POWER

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The F. A. E. S.

FEDERATED American Engineering Societies was the name adopted at the organizing meeting at Washington a couple of years ago for the federation of professional societies which it was hoped was going to make the engineer articulate in public affairs.

American Engineering Council was the name adopted for the body of delegates from the constituent societies.

As The United States of America is to The Congress, so was the Federated American Engineering Societies to American Engineering Council.

At the recent annual meeting of the Council the title Federated American Engineering Societies was abandoned. The collective body becomes American Engineering Council, and the meeting of the representatives of its component societies the General Assembly.

With regard to the "Federated"—or "Council"—there appear to be two schools of thought.

One school considers it as a new national organization, "dedicated," as the preamble to its constitution says, "to the service of the community, state and nation," endowed with powers of initiative, prosecution and performance, in impressing the organized thought, skill and direction of the profession upon the national development of an era in which engineering has come to play a dominant role, but in the over-all administration of which engineers have played a subordinate part.

The other school would regard it as a sort of joint conference committee of its component societies, which must be kept within bounds by concern for existing organizations and not allowed to rock the industrial boat.

I hope that in becoming a Council instead of a Federation there is no implication of surrender to this latter view.

As a militant champion of the public good as it may be furthered by the intelligent application of engineering methods to our national housekeeping, this organization, call it what one may, has a wonderful possibility before it.

As a reference committee it will never justify its existence.

Superheated Steam Used Directly in Closed Heaters

By B. C. SPRAGUE
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A RECENT study has been made of the effect of feed-water heating where economizers were not used, upon the economy of steam-power stations[1]. This has shown that the increase in economy resulting from extracting steam for feed-water heating at pressures where the bled steam is superheated is considerable. Open heaters not being now practicable for use with pressures much above that of the atmosphere, there arises the question of what rate of heat transfer will be obtained with superheated steam in closed heaters.

In making the above-mentioned study it was assumed that the water leaving each heater is at a temperature slightly *less* than that of saturation of the extracted steam. When bleeding superheated steam, this results in a degradation or lowering of the heat of the bled steam, which is practically unavoidable. The complicated arrangement that would be necessary to recover even a part of the superheat of this extracted steam at a temperature above that corresponding to the steam pressure is impracticable. The question then is, Can the feed water be heated to as high a temperature with superheated steam as with saturated steam at the same pressure, other conditions being the same?

THE idea that a greater heat transfer in evaporators or closed heaters can be obtained by de-superheating the steam, rather than using it direct, appears to be prevalent. The author has conducted many tests under various conditions, indicating that heat transfer is the same with both saturated and superheated steam of the same pressure, while the temperature of the tube is below that of saturation. That heat transfers per square foot per hour should be equal, is explained. This article also tells why B.t.u. transferred per degree difference in temperature of steam and water per square foot per hour, is not considered in this discussion.

The writer has made numerous heat-transfer tests, using both superheated and saturated steam. There was *no* reduction in the rate of heat transfer with superheated steam, meaning the B.t.u. transferred per unit surface in unit time. This was the same both with superheated steam and with saturated steam at the same pressure. The temperature of the tube was below the saturation temperature of the steam in these tests.

Although the idea that a greater heat transfer in evaporators and closed heaters could be obtained by desuperheating the steam has been prevalent, the writer is surprised to find a letter published in the Nov. 13, issue holding his views as "obviously incorrect." It is thought that possibly that author has reference to the coefficient of heat transfer determined by using the mean temperature difference between the water and the actual steam temperature, such as T. B. Sando, in his recent contribution (Oct. 23 issue) attempted to show might be calculated.

The question of the relative coefficients of heat transfer is foreign to the subject. In determining whether or not to use desuperheaters, the question is, Will the amount of heat safely transferred be as great with superheated as with saturated steam at the same pressure? It is proposed to show that any expression for the coefficient of heat transfer using the actual steam temperature such as suggested by Mr. Sando would be meaningless, since it would have no positive relation to the actual heat transfer. This hinges on the condition that the external tube surface temperature is the same with both saturated and superheated steam.

The transfer of heat by convection between a fluid such as water and a metal tube surface is accomplished by the movement of particles of the fluid into and out of the film of water in contact with the metal. The heat is then transferred through the thin film by conduction. There is actually no sudden change from the condition where the heat transfer is accomplished mainly by convection to the condition where it is transferred by conduction. The change being a gradual one, it is desirable and sufficiently accurate for the present purpose to make this assumption. Each particle having the temperature of the fluid flowing in the tube gives up, on entering the surface film, an amount of heat proportional to the temperature difference between the flowing fluid and the surface film. Therefore, the total heat transfer will, with other conditions constant, be proportional to this temperature difference.

With constant fluid velocity, viscosity and density, the coefficient of heat transfer will be practically the same with different mean temperature differences. Such an expression for specific conductivity is valuable in that it enables one to predict what the heat transfer will be with other values of temperature difference provided the heat transfer with one value of the temperature difference is known.

External Tube Temperature Is the Same With Both Saturated and Superheated Steam

When heat is transferred from steam to a metal surface, such as the exterior of a tube which is below the saturation temperature of the steam, the conditions are different. In this case the particles of steam entering or coming in contact with the outside surface film give up their latent heat and, if superheated, some sensible heat as well. In giving up this heat, the particles of steam are condensed to water and remain as part of the external water film. Since the outer surface of the water film is at all times in contact with the steam, each particle of steam will give up a large amount of heat when the temperature falls slightly below that of

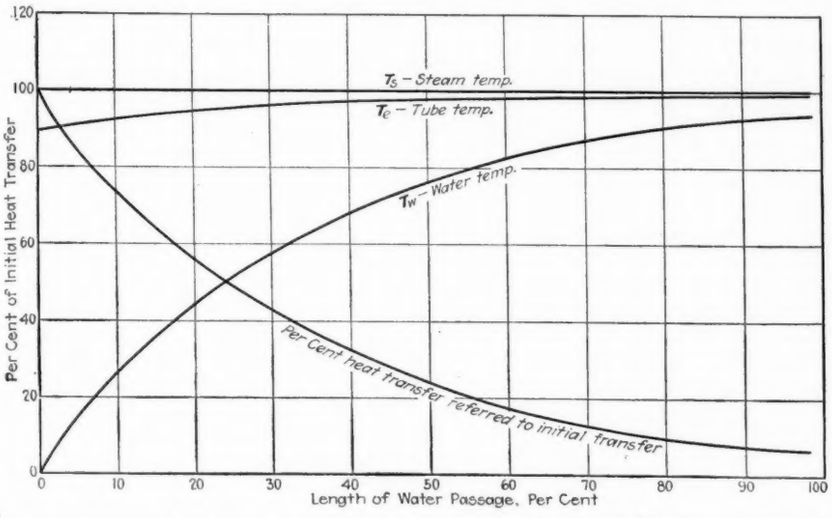
[1] "Effect of Feed Water Heating on Plant Economy," by G. G. Bell, *Mechanical Engineering*, July, 1923, Vol. 45, No. 7, page 417.

saturation. Therefore the outer surface of this film will always be at the saturation temperature.

With superheated steam the temperature of the outer surface of this film will not, with practical conditions, rise above the saturation temperature. This would result in even higher heat transfer in the case of superheated steam. The resistance to heat transfer will, with superheated as well as with saturated steam, under such conditions, be due wholly to the resistance of this water film.

Exterior Film Resistance Is Less than from Water to Tube Interior

The resistance of this film is found to be very small compared to the resistance to heat transfer that occurs on the water side of the tube even with high water velocities. Why the thickness of this film will be different with superheated steam from that with saturated steam is difficult to see. It is logical to expect that the total resistance to heat transfer from steam to a metal surface will be the same no matter how highly the steam is superheated provided, of course, that the temperature of the metal surface is maintained below that corresponding to the pressure of the superheated steam.



Heat transfer decreases as water flows through a closed heater supplied with saturated steam

The transfer of heat in this case is independent of the difference in temperature between the superheated steam and the metal surface. Any expression for the specific conductivity such as the coefficient of heat transfer that is based upon the actual mean temperature difference, will therefore be meaningless and have no practical value.

In the case of heat transfer from steam to water through a metal tube there are two conductances in series—the conductance between the steam and the tube and that between the tube and the circulating water. When it is desired to find the total conductance, the component conductances must, as in the case with electric currents, be converted into their reciprocals of resistances. The total conductance will be the reciprocal of the total resistance which is found by adding the component resistances. With water at room temperature flowing at a velocity of 4 ft. per sec. in a $\frac{3}{4}$ in. O. D. tube, the coefficient of heat transfer between the water and the tube will be approximately 1,200 and its reciprocal or conductance or the specific resistance will be $\frac{1}{1200}$, or 0.0008.

The coefficient of heat transfer is defined as the B.t.u. transferred per square foot per hour per degree Fahrenheit mean temperature difference and the specific resistance as the mean temperature difference necessary to cause a transfer of one B.t.u. per hour per square foot of surface. On the steam side of the tubes the resistance of the water film is very low, and consequently the coefficient of heat transfer from the steam to the tube is high. The tube itself offers some resistance to heat transfer, but this, with clean tubes, is so small as compared with the other resistance, that it may be neglected.

The figure shows conditions that take place when heat is being transferred from saturated steam to water through a tube. The ratio of the temperature drop between water and tube to the total temperature drop, will be equal to the ratio of the specific resistance between water and tube, to the total resistance. The figure shows the variation in temperatures of the water and tube throughout the length of the water passage in the case of saturated steam. When the water approaches the temperature of the steam *Ts*, the heat transfer is reduced. The temperature difference between the tube and the steam (*Ts-Te*) is also reduced, this difference in temperature being proportional to the amount of heat transferred per unit of surface in unit of time.

Suppose that superheated steam is substituted for saturated steam at the same pressure with other conditions maintained constant. The temperature of the tube then cannot rise above the saturation temperature unless the amount of heat transferred is greater up to this point with superheated steam than the total transfer when saturated steam is used.

It will be evident from these considerations that the amount of heat transferred with superheated steam will not be less than with saturated steam at the same pressure. When the temperature of the tube is below that of saturation, the temperature of the outer surface of the water film is also below. The heat transferred will therefore be the same. The temperature of the tube cannot exceed the saturation temperature unless the heat transferred from the superheated steam is greater than from saturated steam, under equivalent conditions. Numerous tests by the author tend to substantiate this theory.

In calculating the specific conductance or coefficient of heat transfer with superheated steam, the mean temperature difference between that corresponding to the pressure and that of the circulating water should be used. With heat transfer from steam to water through a metal tube, the outer surface of the water film is at the saturation temperature corresponding to the pressure of the steam, regardless of how much the steam is superheated. The heat transfer will be proportional to the difference between this steam saturation temperature and the mean water temperature.

A Modern Laundry Power Plant

OUT on West Madison Street, Chicago, the new plant of the Great Western Laundry Co. represents the last word in the modern power laundry. It is equipped with the latest and most approved machinery, such as cascade washers, humatic extractors, floating roll ironers, vento drying tumblers, Prim presses, shirt units and other devices to render five distinctive laundry services. All this machinery has individual motor drive. Automatic electric remote control, taking care of the regulation and reversal of the various machines requiring such action, has been installed, each unit having a distinctive panel and all grouped on a section of the switchboard in the engine room.

Housing this model laundry is a building of brick and reinforced concrete, with an abundance of glass area, three stories high, having a frontage of 95 ft. and a depth of 173 ft. In addition there is an old plant now being remodeled, consisting of a three-story building, measuring 50 x 70 ft., and a one-story building 50 ft. square. Work on the new building began in 1921, and laundry service from it started in July, 1922.

Contrary to laundry practice a modern power plant in keeping with the rest of the establishment, supplies the necessary power, light and hot water. It has a number of special features that may be of general interest.

To carry the electric load a simple automatic engine, 15x16-in., driving directly a 120-kw. three-phase, 220-volt generator at 225 r.p.m., was installed. This machine was overloaded shortly after it was placed in service. By March, 1923, the load had increased to such proportions, owing to the growing business of the company, that a larger generating unit was necessary. Three types of machine were considered: A heavily constructed four-valve engine, a steam turbine, and a unaflow engine. After going into detail, it was found that the steam rate and other considerations eliminated the four-valve engine.

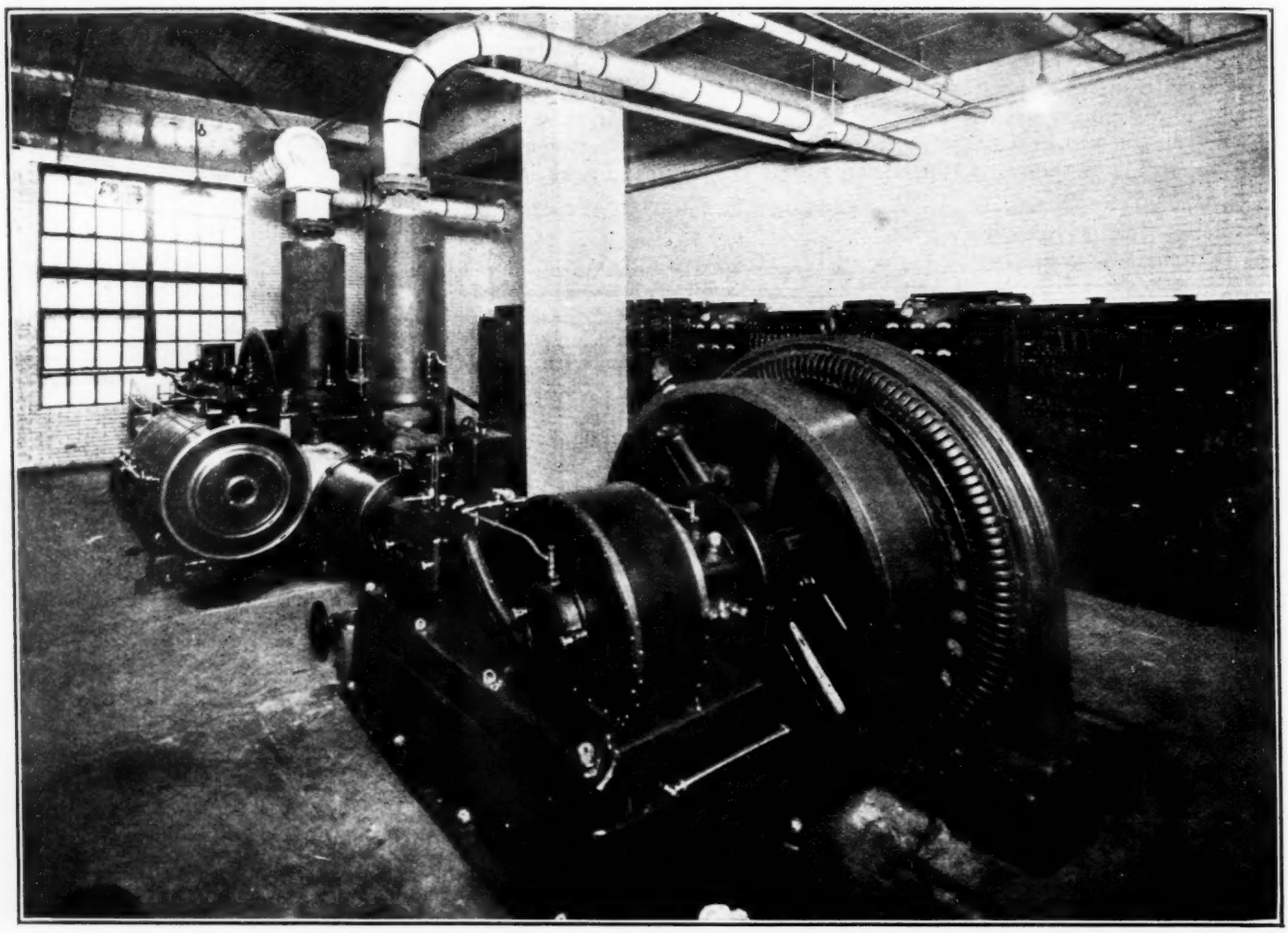


Fig. 1—Engine units in Great Western Laundry Plant

AN INTERESTING plant in which the problem was to balance the power steam with exhaust steam requirements for heating laundry water. In the boiler room fuel spreaders and unusual methods of controlling automatically the feed of coal and water are the features.

The idea of installing a non-condensing steam turbine exhausting against a back pressure up to 5 lb. was rejected owing to the high steam rate under these conditions, it being necessary for economical operation to balance the power steam with the amount of exhaust steam required to maintain the temperature of the laundry water between 160 and 170 deg. F. The unaflow engine under consideration fulfilled this requirement as nearly as could be, and mature consideration resulted in its selection. The generator is a 250-kw. (at 80 per cent power factor) 220-volt three-phase 60-cycle machine.

Additional Power Requirements Will Be Supplied from New Installation

The larger unit has been operating now for several months, and the load has averaged in the vicinity of 50 per cent of its capacity. This condition will be remedied soon, as the engine unit in the old plant now being remodeled will be discarded and the power requirements will be supplied from the new installation. This will add about 75 kw. to the electric load and also increase the demand for hot water, so that practically the same relation will exist between the supply and the demand for exhaust steam.

From actual experience it has been demonstrated that between April 1 and Oct. 15 all the exhaust steam is required to maintain the temperature of the hot water between the limits previously stated. In the colder months more steam will be needed and the exhaust-steam supply will be augmented by live steam, which will be admitted under 10 lb. pressure to the open heater storing the hot water. A temperature regulator attached to this heater automatically turns on the live steam when the temperature of the water tends to drop below 160 deg. and shuts it off when the temperature rises to 170 deg.

On its way to this large open heater the exhaust steam passes through a closed heater to raise the temperature of the boiler-feed water to 210 deg. Three oil separators, one on the exhaust line, one at the closed heater and the third on the open heater, prevent oil from being carried into the laundry water.

Exhaust steam is not used for heating. At present this service is being carried by a low-pressure boiler

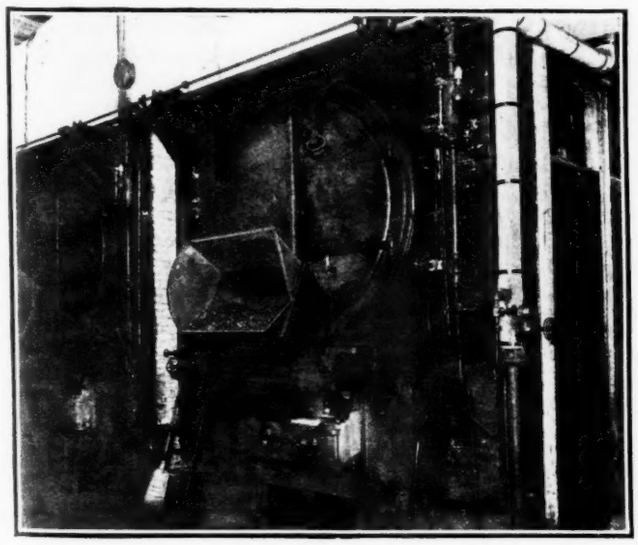


Fig. 2—Return-tubular boilers equipped with automatic feeders

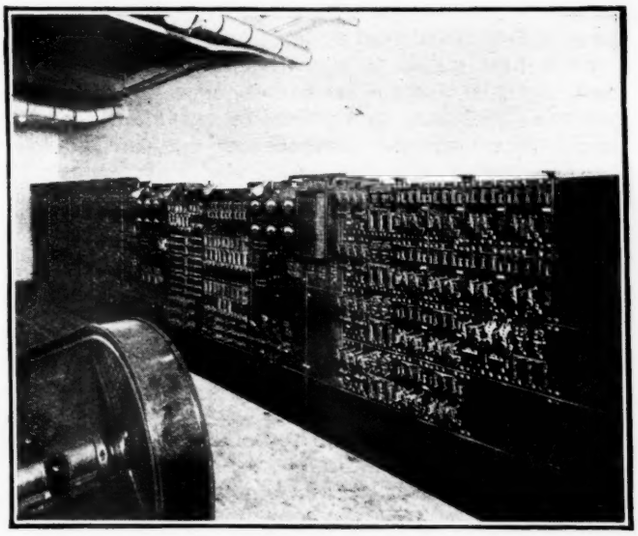


Fig. 3—Power switchboard with additional panels for laundry-control equipment

in the old plant, which in addition to heating the three buildings of the laundry, also supplies steam to eight-apartment flat buildings and five stores taken over to provide additional space for expansion when the demands of the business require it. When the remodeling of the old plant is completed, however, live steam, reduced to 5 lb. pressure, will be drawn from the new plant. The use of exhaust steam will not be considered, as in the colder months the supply is already inadequate.

Three 72-in. by 18-ft. horizontal return-tubular boilers, with space for a fourth unit, was considered ample provision for the steam demands of the plant. Saturated steam at 150 lb. pressure is generated. The boilers were equipped with shaking grates and for a short period were hand fired. To maintain capacity, it was found necessary to use Southern Illinois egg coal rather than the cheaper grades. Owing to the human element and a varying load, the pressure varied considerably and the smoke produced brought complaint from the city.

Automatic Feeder Installed

To improve these conditions and to eliminate objectionable smoke, mechanical means of feeding the coal were considered. Lack of headroom prevented the choice of the single-retort underfeed stoker used commonly on boilers of this size, so that the selection settled upon an automatic feeder designed to distribute the fuel evenly over the entire grate surface. A continuous light feeding of fuel is maintained with this equipment, the fuel bed being 3 in. or less in depth. Closed firedoors reduce the admission of excess air into the furnace. This feature, in conjunction with the continuous feeding of small quantities of coal, has reduced the smoke to a degree satisfactory to the city.

It is now possible to burn the fine and cheaper grades of Illinois coal. The fuel is shoveled into the hopper of the feeder and pushed onto a rotor by means of a push box traveling back and forth under the discharge gate of the hopper. The length of the stroke of the push box is determined by the position of an adjustable nut on a regulating cam. The rotor is made up of a series of blades set at angles on horizontal rods running lengthwise of the drum. This drum has chain connection to a secondary shaft, belt-driven from a primary

shaft extending across the boiler fronts to serve the three boilers and driven by a 4-hp. vertical engine.

When first placed in operation, these feeders were hand-regulated and the results were not entirely satisfactory. Therefore an automatic regulator was installed to control the damper and the rate of feed simultaneously. The equipment used was a standard damper regulator with a shaft extending across the boiler fronts. Arms on this shaft with chain connections to the dampers and the controlling cams on the feeders, gave the regulation desired. The controlling factor is the steam pressure, and this is held within a range of two pounds.

Below the feeder the usual firing doors have been retained, so that the coal may be hand-fired in case it is too large to be handled by the feeder or should the feeder be out of commission for any reason. Lack of a full set of instruments, now on order, has prevented accurate testing of the new equipment. According to an estimate by the chief engineer, the two boilers carrying the load are operating close to 200 per cent of rating.

Coal is received in a storage bunker under the driveway and from this bunker is wheeled to the boiler fronts to be shoveled into the feeder hoppers. The ashes are removed by a steam-jet ash conveyor discharging into a tank on the roof of a building across the court. From here the ashes are chuted into trucks on the driveway.

Water Is Softened for Laundry Use

For laundry use and for boiler feed, water is originally drawn from the city mains. Although Lake Michigan water is sufficiently good for all ordinary purposes, it was considered advisable to soften it for laundry use. To do this a zeolite softener having a capacity of 300,000 gal. of water in ten hours was installed. This water is delivered under float control either to the large open heater on the roof or to a 40,000-gal. cold-water storage tank nearby.

An automatic motor-driven pump and receiver outfit has been provided to receive the returns from the heating coils and force the condensation to a large receiver over the boilers. Returns from the closed feedwater heater and also from the steam-using equipment in the laundry are trapped and forced up to this same receiver. Two large return traps of the tilting type transfer the water from the receiver into the boilers. Makeup comes from the hot-water storage on the roof to the receiver over the boilers under float control and by gravity, passing on its way through the closed feedwater heater. As a reserve method of feeding the boilers two duplex steam pumps have been provided. They receive their supply from the storage tank on the roof and force the water through the closed heater to the boilers.

A feature of the feed-water system is the method of controlling the operation of the return traps. At the boiler end of the steam lines to the traps, pipe nipples extend to the desired water level in the boiler, represented by 3 in. of water in the gage glass. When the water in the boiler rises above this level, the end of the nipple is below the water line, so that the trap is sealed and does not operate. When the water drops below the desired level, boiler steam enters and operates the traps. The provision gives practically a constant water level all day long. It is entirely automatic and with automatic control of the coal feed as well, uniform conditions favorable to economy are maintained throughout the daily operation.

For the design and general layout of both the laundry and the power plant, credit is due the engineering department of the American Laundry Machinery Co., working in co-operation with the laundry owners, the Levitetz Brothers, and Peter N. Berens, chief operating engineer of the plant.

PRINCIPAL MECHANICAL EQUIPMENT IN THE POWER PLANT OF THE GREAT WESTERN LAUNDRY CO.

Boilers and Auxiliaries

Boilers, return tubular, three.....Ames Iron Works
Size .....72 in. x 18 ft.
Steam, saturated, pressure, lb. gage.....150
Grates, 6x6-ft.....One Martin, one Cyclone, one Dorrance
Coal feeders, three.....Automatic Furnace Co.
Feeder drive, vertical engine, 4 hp.....E. H. Wachs Co.
Feeder and damper regulator, Ajax.....National Regulator Co.
Ash conveyor, steam jet.....Brady Conveyors Corp.
Stack brick, diam, 6 ft.; height 175 ft.,
Singer-Kennedy Chimney Co.
Return traps, two, Cranetilt.....Crane Co.
Steam traps on laundry machinery, ten Cranetilt.....Crane Co.
Feed pump, one, duplex, 5½ x 3¾ x 5 in.,
Worthington Pump & Mach. Corp.
Automatic motor-driven pumping outfit, heating returns,
Economy Pumping Machinery Co.
Water softener, 300,000 gal. per 10 hour.....Permutit Co.
Pumps serving softener, two 4-in. cent. driven by 30-hp. G. E. induction motors .....Dayton-Dowd Co.
Heater, feed water, closed, 15,000 lb. per hour.....Sims Co.

Generating Units

Engine, one, single-valve side-crank, 15 x 16 in., 225 r.p.m.,
Ames Iron Works
Generator, 120 kw., 220-v., 3-phase, 60-cycle, 225 r.p.m.,
General Electric Co.
Engine, one, Poppet valve unaflow, 23x24 in., 200 r.p.m.,
Ames Iron Works
Generator, 250 kw. at 0.8 p.f., 220-v., 3-phase, 60-cycle, 200 r.p.m.,
General Elec. Co.
Switchboard, electrical instruments,
Jewell Electrical Instrument Co.
Electrical control, laundry machinery....Cutler-Hammer Mfg. Co.

Hazards of Induced Voltages in Excitation Systems

By Ralph Brown

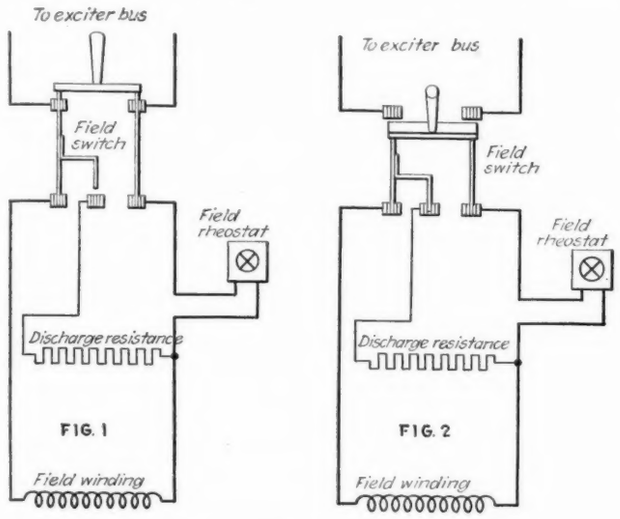
If the current flowing through the field winding of a generator is suddenly interrupted, the inductive nature of such a circuit causes a voltage greater than that applied to be induced in the winding. The magnitude of this induced voltage depends upon two factors; namely, the rate of change in the magnetic flux, and the amount of flux (lines of magnetic force). The amount of flux depends upon the dimensions of the magnetic circuit and the number of ampere-turns. Since an alternator of low rating would require a magnetic circuit of small dimensions, as well as a comparatively few ampere-turns, the field circuit of such an alternator could probably be opened without a dangerous voltage being induced therein. An alternator of high rating would require a large field structure and a large number of ampere-turns. Therefore, if the current flowing through the field winding of a large alternator is suddenly interrupted, the induced voltage may attain several times the value of the applied voltage.

Field-Discharge Resistance

To limit the voltage that may be induced in a field winding, a field-discharge resistance, Fig. 1, is connected in parallel with the winding just before it is disconnected from the source of excitation. This resistance is automatically inserted by the opening of the field switch or field circuit breaker without thought on the part of the operator. After the field winding is disconnected from the exciter, the induced voltage causes current to flow through the discharge resistance, Fig. 2.

resulting in a gradual decrease in current, and this slow change, as well as the work done in heating the resistance, prevents the field circuit voltage from increasing above normal. In other words, the energy otherwise effective in inducing a high voltage is dissipated as heat.

Since the field-discharge resistance normally carries current for only a few seconds after the field switch is opened, a small resistance box is suitable for the largest alternator. Care must be taken to see that the discharge resistance is not, due to faulty field-breaker operation, connected for any length of time to the circuit when



Figs. 1 and 2—Exciter-field connections

the breaker is closed, or the resistance will surely be burned out. Frequent tests should be made to determine that the discharge resistance has not become open-circuited and to make sure that the discharge blade makes proper contact with its clip when the breaker is being opened, also that the discharge resistance is disconnected before the field breaker closes.

While a field circuit can become open-circuited at any point between the positive and negative exciter busbars, such as in the field rheostat, in the connecting cables, or even at the collector rings, the splices between adjacent field coils are likely to prove the weakest points in the entire circuit. Several failures of such splices have occurred, sometimes with serious results, and it is essential that field splices be electrically and mechanically perfect, and securely clamped, if necessary, to prevent movement. In one plant the factory-made field splices proved so unreliable that it was found advisable to reconstruct all of these splices on several large generators. By tinning the copper strap usually forming the splice, then interleaving the conductors and riveting or bolting them together, a final "sweating" will insure a dependable connection. Obviously, great care should be taken in soldering on all lugs or terminals that carry field current, and only cables of ample current-carrying capacity should be selected for this exacting service.

Frequent examinations should be made of all splices, lugs and terminals carrying field current for any evidence of heating. Stationary connections can be inspected at any time, but the field splices can be examined only while the rotor is at rest and access can be had to them. Each field splice should be felt with the hand while full-load current is flowing, to detect excessive heating, and it follows that a suspicious splice should be attended to without delay.

The fact that high voltage may be applied to the exciter bus by the open-circuiting of a field winding is an important reason why control circuits should never be connected to the exciter bus. If high voltage enters the control circuits, a number of switch indicating lamps will probably be burned out, making it difficult for the operator to clear the trouble, and part of the control apparatus is likely to be damaged. Furthermore, control-circuit fuses will probably be blown, making the control equipment inoperative at a time when it is urgently needed.

In most large stations the control circuits are separated from the exciter circuits, but in some cases, owing to close proximity of the two systems of wiring, voltage has entered the control system by jumping comparatively long air gaps. For this reason the control and exciter circuits should be particularly well insulated, or it will be found that they will become electrically connected when high voltage appears in the exciter system. Any auxiliary circuit connected to an exciter bus should be protected by 600-volt fuses, for fuses having a lower-voltage rating than this may not interrupt the current.

Since connected apparatus may become damaged if 1,200 or 1,500 volts is applied to the exciter bus, every reasonable precaution should be taken to prevent a failure of alternator-field circuits. Careful installation and frequent inspections will greatly reduce the possibility of trouble arising from such a failure, but it is thought advisable to connect aluminum-cell lightning arresters to the excitation busbars, to prevent any dangerous increase in the exciter voltage. Such arresters are inexpensive, yet effective in their action, and being connected to a direct-current circuit, the film on the aluminum plates is maintained without the operator's attention.

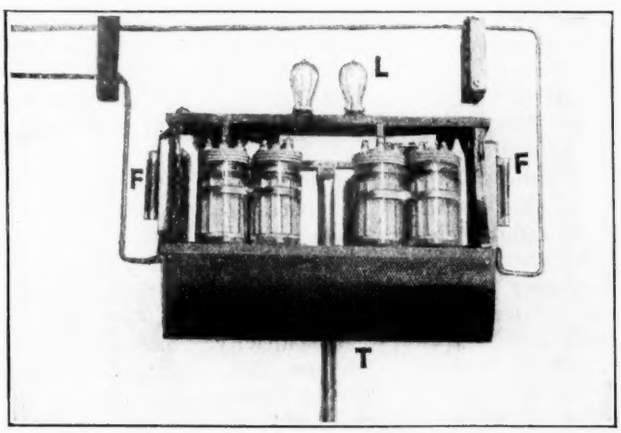


Fig. 3—Lightning arrester arranged for connection across exciter busbars

Fig. 3 shows an aluminum-cell lightning arrester consisting of four cells, connected through 600-volt fuses *F*, to a 250-volt-exciter bus. The connection to earth is made by means of the vertical copper tubing *T*. The two pilot lamps mounted on the arrester housing are connected in series across the cells and become extinguished if either of the fuses blows. Since the arresters are placed in a conspicuous location, immediate attention is directed to a defective fuse by the extinguishing of the pilot lamps.

Insuring the Refrigerating Plant Against Shutdown

By H. M. Toombs

Now is the time to protect the refrigerating plant against future losses. It is too late when the mercury nearly boils in the thermometer. Dollars invested in repairs now will show big profits.

Every year as soon as cold weather comes every one talks about preparing for summer, but talk as one may, each summer thousands of dollars are lost by spoilage from lack of proper temperatures. There are, of course, many ways in which the operating man can help himself when he finds the temperature slowly mounting, but the real cause is nearly always poor condition of the equipment. Everyone, even the expert, is handicapped and can only make quick repairs and provide emergency measures while the system is in complete operation. Needless to say, alteration and repairs should be made in the colder months of the year, when the plant load is low.

The important parts of the compression refrigerating plant are the condensers, expansion coils and liquid receiver. They are closely allied and must act as a unit to produce the best results.

Examine the Condenser

If the condensers are dirty or covered with moss, mud or scale, it will greatly reduce the capacity of the entire system. Scale is one of the best insulators known. It prevents the cold water from coming into intimate contact with the hot gases. The capacity of the condenser is lowered in direct proportion to the thickness of the scale. Any accumulation in the pan underneath an atmospheric condenser should be removed, as should any moss that may have accumulated on the pipe. The water distributing ducts or pans should be cleaned and the outlets so proportioned that water flows over coils in an even stream covering the entire surface of each pipe.

If a double-pipe condenser is used, little can be done while the system is in operation, so that it should be thoroughly cleansed both inside and out.

Another source of trouble and expense is a leaky condenser. Not only must the expensive refrigerant lost by leakage be replaced sooner or later, but the leaks reduce the system's capacity. Small leaks can readily be detected by the use of a sulphur stick, which in the presence of ammonia throws out a dense white cloud of smoke. Large leaks are readily noticeable from the odor. Leaks occur at flanged joints, and for this reason worn gaskets and rusty bolts used to make up the joints should be renewed.

Valves on the condenser are also a source of trouble and should be repacked and fitted during the overhauling. When in good condition they operate easily, seat tightly and do not leak.

Some concerns having a large number of condenser stands keep a man working on them at all times. The right man will save his salary many times by quickly detecting and stopping innumerable small leaks that could not be found except by test, but after all, winter is the time to do the overhauling.

If a brine-circulating system is installed, the expansion coils and brine tank should be cleaned. The coils may be disconnected, gaskets renewed and the oil drained from them. They must be thoroughly steamed out and dried with air. The valves should be examined and all parts put in working condition. These precautions serve to increase the plant capacity. The real work of refrigeration takes place in these coils, and if ammonia did not cost so much money and was not so easily lost, we would not be concerned with a yearly inspection.

The compressor, the heart of the system, must run day in and day out during the warm months, and unless absolutely compelled by accident or necessity for repairs, the machine is on the line continuously. For this reason few repairs can be made without shutting down the entire system.

The routine of going over a compressor is as follows: The heads of the compressor are taken off, the valves removed and examined for pitting, any worn seats or valve stems as well as weak or broken springs repaired. The cylinder should be gone through to see if it is scored or out of round; if so, reboring may be necessary. Piston rings must fit tightly against the walls of the cylinder, for there must be no possible chance for the gas to bypass the piston. Scored rods and rods with flat spots cause loss of gas through the stuffing boxes and cause the majority of packing troubles. If the main bearings are running warm the caps should be taken off to see if the babbitt is glazed and the oil grooves free. Likewise the steam end should be thoroughly inspected and any defect noted. The steam losses can be equally as great as those on the compressor if the machine is not in good operating condition. Once the machine is closed up after overhauling, it should be in such condition that, barring an accident, it need not be opened for another year.

Volumetric Efficiency Counts

Another important point is the clearance between the piston and the cylinder head in vertical single-acting compressors. This clearance should be made as small as possible—just enough that the piston does not strike the head when the machine is working under its most disadvantageous conditions. The smaller the clearance the greater the volume of gas handled.

Above all things do not try experiments with machines. If one is thinking of altering a machine, he should consult someone who thoroughly understands the problem before the alteration is made.

Outside of the engine room are many small details to be looked after. They are highly important and unless properly attended to will reduce the plant's capacity. Their condition plays no small part in establishing one's reputation as a competent or incompetent operator. The proper insulation of cold-storage warehouses and cellars has been pretty well understood. However, loose-fitting doors and windows as well as holes punched through walls, allow streams of warm air to pour constantly into the cooler and are found in many high-grade plants. The operating head should closely inspect the coolers and, should any of these conditions exist, see that they are corrected at once. The loss due to a single leak does not amount to much, but collectively the loss is enormous.

Uncovered brine lines cause more loss than is realized. Wherever white frost appears on an outside line, one can be certain that the brine is picking up heat from the atmosphere. All such lines and fittings should be covered at once. Rotten or water-soaked coverings are worse than useless, not only looking bad but also

causing losses equal to those of a bare pipe. The practical application of brine-pipe covering is an art, and if properly handled the covering will last for years. Good work is expensive but pays an excellent return in increased capacity.

Many of the knotty problems arising in the warm months are traced directly to poor refrigeration. A little study by the operating head will often solve them. Inspect the refrigerating system thoroughly. Take a walk up to the condensers and see if they really are clean. Stop the leaks that are costing you money. Make a record of defects on the machines and when the opportunity comes see that the defects are corrected. Go over the coolers minutely and eliminate all openings to the outside. Thoroughly insulate the lines running out of doors or through hot rooms. Defrost all pipe coils systematically. Only by proper overhauling in the winter followed by frequent inspection during the operating season can one hope to obtain capacity out of the plant.

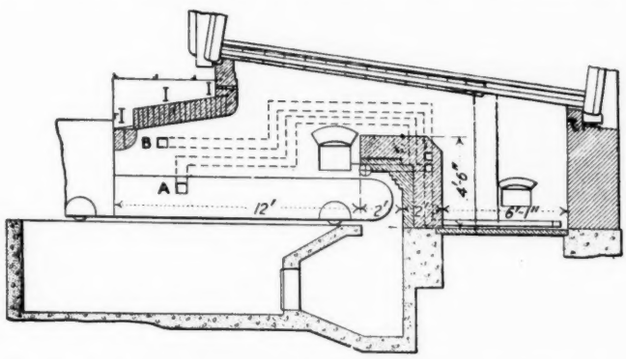
Preheating Air To Reduce Smoke

It is not a difficult problem to burn the bituminous coal of the Middle West without producing objectionable smoke provided proper attention has been given to the initial furnace design, the draft and the boiler setting in general. To clean up an existing plant, however, that has been installed with little or no attention to the aforementioned factors without remodeling the boiler settings, is not an easy task. In this connection the experience of Hart, Schaffner & Marx in their main plant in Chicago may be of interest.

This plant serves a twelve-story building occupying about two-thirds of a city block and another five-story building and also supplies steam to a number of stores for heating and press machines. The load fluctuates to an unusual degree, coming off and on in heavy swings without notice, so that a bad situation is aggravated, making it more difficult to operate without producing smoke.

Originally, the plant contained three 2,500-sq.ft. boilers, two of which were equipped with hand stokers. A growing demand for steam, however, necessitated the removal of one of these boilers and the installation in its place of a cross-drum, horizontal water-tube boiler, containing 4,000 sq.ft. of heating surface, horizontally baffled and served by a chain-grate stoker. It was necessary to make the change quickly so that requirements for smokeless operation were not given due consideration. With the plant located in the basement and space requirements limited by the existing installation, sufficient headroom was not available to give more than seven feet from the floor to the bottom of the front tube header. This resulted in a furnace too small to permit efficient combustion at any load exceeding nominal rating. In addition to this unfavorable feature certain restrictions were imposed in the gas passage at the outlet of the boiler, so that an ample draft from a high stack was so much reduced that it was impossible to carry the usual load with screenings. No. 3 nut coal was burned, and with this fuel the larger boiler alone met all demands except in the very coldest weather. The smoke, however, was dense and brought so many complaints from the city that it was essential to improve conditions.

Changing the fuel to No. 4 nut and even No. 5 did not eliminate the smoke, although there was a slight improvement. Continued complaints made more drastic action necessary, and this action consisted in installing air ducts in the side walls and the floor of the combustion chamber back of the bridge wall to preheat a portion of the combustion air. By drawing the air from a point between the two runs of chain, passing it back through the duct system and discharging it over the fire at the front of the furnace, a decided improvement in combustion efficiency resulted. The preheated air coming out of the ducts produced a hot, incandescent fire back to the gate and reduced the slag and carbon deposits on the tubes. The volatile gases were burned more completely, and with a higher furnace temperature, better heat absorption was obtained in the boiler. Also, the fuel on the grate was burned out more completely, this being evidenced by the report that the total quantity of ash was reduced by 50 per cent with the same fuel and approximately an equivalent demand



Vertical Section Through Furnace Showing Location of Air Preheating Ducts

for steam. No evaporation tests have been made, so that the exact improvement in economy is not known. The reduction of unburned carbon in the ash and the appearance of the flame in the furnace give ample indication of improved combustion, and relative to the main object sought the smokeless range of the boiler has been carried up to 200 per cent of rating or better, with a mixture of Nos. 4 and 5 nut coal. With coal larger than this, even with the better conditions that now exist, some smoke is produced, due probably to the sudden changes in the load.

Reference to the illustration, a vertical section through the furnace, will give some indication of the duct arrangement. From the inlet *A* below the upper run of chain, the duct rises up into the furnace region, then passes back and down through a pier in the bridge wall into the floor of the combustion chamber, where it proceeds to the rear end and doubles back, returning through the same side wall to deliver the heated air over the fire from the outlet *B*. A similar duct is placed on the other side of the furnace. The ducts are made of brick, tile and high-temperature cement, and are so proportioned that under specific conditions a definite proportion of the air for combustion will pass through and be heated. The quantity of air passing through the ducts naturally varies with the density and thickness of the fuel bed, the rate of combustion and the temperature of the furnace. The installation was made by the Foltz Smokeless Furnace Co., 15 East Van Buren St., Chicago. A similar installation for return-tubular boilers in the plant of S. Karpen & Bros., Chicago, was described in the Aug. 10, 1920, issue of *Power*.

Boiler-House Efficiency

By JAMES T. BEARD, 2ND

High CO_2 is only one element of high over-all efficiency — Consideration must also be given to loss of fuel through grate, incomplete combustion and poor heat absorption due to soot, scale and leaky baffles. Complete combustion, high CO_2 and good absorption insure efficiency.

NOT long ago there appeared in the columns of *Power* an editorial entitled, "Does High CO_2 Mean High Boiler Efficiency?" in which it was pointed out that other factors entering into the efficiency of a boiler installation may offset the benefits of a high percentage of carbon dioxide in the flue gases.

Naturally, in the limited space it was not possible to treat the subject in detail, but merely to call attention to a false conclusion that is sometimes reached by engineers, and to endeavor to set them right. Inspired by that editorial, this article will attempt to analyze the factors entering into the combined or over-all efficiency of a boiler, to point out how they are related to one another, to show how they are influenced by the design of the equipment, and to indicate what steps may be taken to increase the efficiency by the prevention of excessive losses.

The Three Essentials

Consider for a moment a single boiler unit in a power house. It consists essentially of the boiler itself, the setting (including the furnace) and the grate or stoker, as the case may be. Each of these individual units has a distinct function to perform—a work to do. The efficiency with which each does its task is shown by its output, as compared with its input.

Combined efficiency, therefore, or the over-all efficiency of a boiler installation, consists of three separate and distinct efficiencies; namely, the efficiencies of the three units making up the boiler installation. Combined efficiency is also dependent to a large degree upon the human element.

The ultimate aim in the boiler house is to convert heat units in the fuel into heat units in steam under pressure, with as little waste as possible. In a coal-burning plant this means:

1. Burning all the coal completely.
2. Presenting maximum intensity of heat to the boiler-heating surfaces.
3. Transferring the maximum amount of heat from the furnace gases to the water and steam in the boiler.

To burn all the coal completely is the function of the grate or stoker. Correct distribution of the air necessary for combustion throughout all parts of the fuel bed is essential. Where the air supply is inadequate, the combustion rate may be appreciably less than in other parts of the fuel bed, with the result that considerable unburned coal may eventually find its way to the ashpit.

The grate acts as a mechanical support for the bed of coal. In this rôle it must also permit the free passage of air to the fuel. Necessarily, therefore, there must be spaces or openings through which the air can flow. Unless the grate is properly designed, these same holes may also allow unburned coal to drop into the ashpit.

If the coal is to be burned completely therefore, the grate must support the fuel bed with a minimum loss of siftings and must distribute the air supply evenly and adequately throughout the fuel bed, in proportion to the combustion requirements in every part.

As a unit by itself the grate receives so many pounds of coal to be burned. Consider this as the input. If the grate is properly designed, most of the heat within this coal is released. That is the output. A small amount of unburned carbon inevitably finds its way to the ashpit as a loss.

The efficiency of the grate, therefore, is a measure of its ability to release all the heat in the coal delivered to it. It decreases as the amount of combustible in the ash increases.

First Comes the Grate or Stoker

There are many designs of grates and stokers for accomplishing efficient distribution of coal and air over and through the grate area. Small sizes of coal require a support that will prevent excessive loss of combustible into the ashpit. The openings are, therefore, small as compared with grates for burning the larger sizes of fuel. In general the best design of grate for a given fuel will be one with the maximum ratio of air space to total grate surface, without sacrificing any of the necessary support for the fuel to be burned.

Some grades of coal have a tendency to cake, forming a crust over the fuel bed, through which no air can pass. This crust must be broken up with the slice bar in most hand-fired installations. In some of the various types of hand stokers the same result may be accomplished to a certain extent by the rocking action which is periodically imparted to the grate bars.

Many types of automatic stokers attempt to break up this crust by the mechanical movement of the grate bars, and in some types provision is made for a slicing action of the retort sides.

In the operation of grates and stokers one of the greatest factors to contend with from the viewpoint of efficiency is the human element. The maintenance of a good bed of fuel is of great importance, as is also the proper regulation of the drafts. Poor economy is more

often chargeable to careless firing than to poorly designed grates or furnaces.

Where fairly intelligent labor is available, or where the supervision is good, draft gages and other instruments keep an accurate check on the human factor and give visual indication of careless or shiftless methods. When the information they give is properly interpreted, they materially assist in determining correct operating conditions and in the continuous maintenance of those conditions.

Where the grade of labor is below the standard and where supervision is only ordinary, it is good policy to install automatic devices that will take draft regulation out of the hands of the fireman.

There are few cases where a few simple instruments will not prove a profitable investment. If they are properly explained to the men in language they can understand, they will use them.

Cleaning Fires Takes Skill as Well as Brawn

One of the largest sources of loss in grate efficiency is careless cleaning of fires—another case where the human element plays an important part. It is a mean job at best, and a hot job, too. The big idea is to dump the ash and put the boiler back to work as soon as possible. Naturally, considerable good coal follows the ash into the pit. If the coal is high in ash, the total loss will be greater than with a low-ash coal. A certain amount of loss is inevitable, but it can usually be greatly reduced by properly burning down the fires before cleaning and by using reasonable care in dumping. Where the boiler capacity of the plant is limited, the time for cleaning each boiler is also limited and the loss will be greater than in a plant that is not overloaded.

Another source of loss, and usually the largest, is the excessive amount of air supplied to the fuel bed to burn the coal. Any air that passes into the furnace without burning coal serves only to cool the temperature of the furnace and does no useful work. It "dampens" the fire.

The cause of this excess-air loss is usually a poorly conditioned fuel bed—another case of the human element. The bed may be burned out in spots, or it may be too thin. We are dependent upon the fireman for keeping the fires covered with live coal at all times and for maintaining the proper thickness for best results.

How Poor Firing Lowers CO_2

When the condition of the fire permits an excessive amount of air to pass the fuel bed, this loss is indicated by the percentage of carbon dioxide, or burned coal, in the flue gases. When the plant is operating at best economy, this percentage will be in the neighborhood of 14 per cent. If it is less than that, it indicates that the flue gases have been diluted with air. The percentage of CO_2 in the flue gases is, therefore, not an indication of the boiler efficiency, but rather an indication of the efficiency and ability of the fireman himself. It has nothing to do with the boiler proper, but it has a material effect on the combined efficiency of the installation.

But excess air may be due to other causes than careless handling of the fires. There may be cracks in the furnace setting, through which cold air from the boiler room flows and mixes with the furnace gases. If this mixture occurs before the gases have passed the boiler tubes, the loss in efficiency is indicated by the small percentage of CO_2 in the flue gases. If the admixture of air with the flue gases occurs after the gases have passed the tubes, there is no loss in the combined efficiency from this cause, although the CO_2 reading would indicate such to be the case. Such a loss would be detrimental, however, inasmuch as it would decrease the stack temperature and increase the volume of flue gases, thereby decreasing the draft.

The Harm Done by Excess Air

Since the presence of excess air in the furnace gases tends to lower the temperature within the furnace, it is obvious that, if the maximum intensity of heat is to be presented to the boiler-heating surfaces, excess air must be eliminated in so far as it is practicable to do so. In actual practice, particularly when the boilers are being forced beyond their normal rating, there will always be an appreciable percentage of excess air. Even with the best designs of grates, stokers and furnaces, the intimate mixture necessary for complete combustion without excess air is not possible. The first essential in boiler-house operation is to maintain the steam pressure. Economy of operation, although of great and vital importance, must necessarily be a secondary consideration. At high ratings, therefore, the amount of excess air will increase, since it becomes necessary to increase the velocity of air through the fuel bed in order to maintain steam pressure constant, thereby decreasing the time of contact between the air and the coal.

Tests will indicate the most economical rating of the stoker or the grate, if proper instruments are available. For different fuels it will be found that a maximum percentage of CO_2 is obtained at quite different rates of combustion, that is, pounds of coal burned per square foot of grate per hour. It is desirable to maintain this economical combustion rate by cutting boilers in or out of service where this is possible. Sometimes it is desirable and possible to maintain an even combustion rate on all boilers but one, allowing the one to absorb and take care of the fluctuations in plant load. In such cases there is but one stoker or grate burning coal at a variable degree of economy.

Grate Must be Proportioned to Boiler

The most economical rating of the grate must not be confused with the most economical rating of the boiler. These may happen to coincide. They will if the grate area and heating surface have been properly proportioned for the coal that is being burned. But if the grade of coal varies, a coincidence will be impossible. The boiler is designed to operate at maximum economy at a given velocity of gas flow through the tubes. If it is known that the boilers will be expected to develop a given rating continuously, the designers, can then build them to meet these conditions with a boiler that will give maximum economy. A change in the conditions may, in some cases, be met by changing the baffles. In any case the steam demand and coal consumption should be studied, in conjunction with the grade of fuel burned, with a view to proportioning the grate surface properly, so that maximum operating economy for both boiler and stoker will occur at the same time.

We have seen that, to present the maximum intensity of heat to the boiler-heating surfaces, a well-conditioned fire is essential. But efficient combustion and maximum

furnace temperature are also dependent upon proper furnace design.

Time is required for the complete burning of coal gas by the air that is mixed with it. Also the mixture must be intimate if best results are to be obtained. The flames rising from the fuel may have to travel some distance before the gas is completely consumed. If they strike a relatively cool surface (such as the boiler tubes) before they are burned, the chilling effect causes a precipitation of carbon, or soot, which is no longer combustible under these conditions and which deposits on the surface of the tubes.

The result is twofold: First, that part of the coal represented by the soot has not been burned and represents an irretrievable heat loss, consequently maximum intensity of heat has not been realized; second, the soot formed around the boiler tubes, insulates them from the active heat in the furnace, and the gases passing through the tubes cannot surrender their full share of heat to the water in the boiler. This latter effect will be considered later in the story.

Flame Should Not Strike Heating Surface

It is essential, therefore, that the furnace be so designed that air for combustion will be thoroughly mixed with the burning gases and that there be sufficient combustion space for the gases to burn completely before they strike the colder heating surfaces of the boiler tubes and shell.

The size of this combustion space depends upon the kind of coal that is being burned. Hard coals have little volatile gases in their composition and require less combustion space than the high-volatile soft coals. In some cases it may be found desirable and efficient to admit preheated air over the fire, in order to insure a sufficient supply for burning the gases that are distilled from the coal lying on the fuel bed. Many stoker manufacturers have adopted as a standard a minimum height of 10 ft. between the top of the grate and the under side of the front header of the boiler. This cannot always be secured in the case of old installations already in place. In many new installations they have gone to a height of 13 ft. and even more.

Function of the Boiler Itself

The efficiency of the boiler itself is our last consideration in this article and consists of the transferring of the maximum amount of heat from the furnace gases to the water and steam within the boiler tubes and shell. Naturally, this depends on the cleanliness of the metal surface and the length of time the hot gases are in contact with those surfaces.

When the boilers are being forced, the velocity of gases through the tubes is great and the transfer of heat from gases to water is bound to be less than at moderate boiler ratings where the velocity of the gases is reduced and the time of contact is increased.

Over this factor we have no control except, as stated before, to endeavor to distribute our plant load among the boilers, so that all but one are operating at their point of maximum economy.

The heating surfaces of the boilers may become fouled, moreover, either by the gradual accumulation of soot upon the outside of the tubes or by the deposit of scale from impure feed waters on the inside of the shell and tubes. Such deposits prevent the efficient transfer of heat to the boiler or, if you will, the efficient absorption of heat by the boiler.

The best indication of dirty heating surfaces is an increase in the temperature of the flue gases leaving the boiler. Since the gases have been unable to give up their heat, they leave the boiler much hotter. This surplus of heat is carried up the stack and often amounts to an appreciable dead loss.

Broken baffles may also cause a short-circuiting of the furnace gases, thereby decreasing the time of contact between those gases and the metal heating surfaces. Such a condition will also cause a marked increase in flue-gas temperatures and an appreciable preventable heat loss.

Flue Temperatures Signal Dirty Tubes

If suitable flue-gas pyrometers or thermometers are provided, a gradual increase in these temperatures may be detected before it has become excessive, and the cause investigated.

When permanent soot blowers are installed and used regularly and properly, the accumulation of soot deposits on the outer surface of the boiler tubes may be effectually prevented. Where there are no soot blowers, the tubes must be blown at regular intervals by the steam hand lance. These statements may appear like common horse sense. They are; but the writer has found that, unless these simple boiler-house duties are consistently followed and checked, they will not be properly performed.

Internal cleaning of the boilers is always costly, if there is much of it to be done. Not only is the heat loss in cooling down the boiler and firing up again considerable, but the labor involved and the loss in boiler capacity often make a big item.

Where impurities in the feed water make excessive boiler cleaning essential, some sort of water-softening or water-treating program should be adopted. In many cases the first cost of such an installation is paid for in a few years and the reliability of plant service greatly increased during that time. Whatever method is used, the tubes must be kept clean, inside and out.

To Sum Up

To sum up, boiler efficiency involves many factors. It depends upon furnace temperatures, which in turn are affected by the percentage of CO_2, or the efficiency of combustion on the grates and in the furnace. It depends also upon the flue-gas temperatures, which are governed by the cleanliness of the boiler-heating surfaces and by the condition of the baffles and setting. It depends likewise upon the velocity of the gases through the boiler setting, which is influenced by the capacity developed by the boiler and which materially reduces or increases the flue-gas temperature due to the lengthening or shortening of the time of contact between the gases and the heating surfaces of the shell and tubes. It depends, moreover, upon the siftings through the grate, the care and time taken in burning down and cleaning fires, the kind of coal burned, design of boiler, grate and furnace, and other minor factors.

In maintaining those conditions favorable to high boiler economy, the efficiency and ability of the human element is a vital factor, involving correct knowledge of conditions in the fuel bed, in the furnace and setting, and within the boiler itself. Depending upon the interpretation of this knowledge, in the matter of adjusting, correcting and controlling these operating conditions, the efficiency of the boiler unit will be maintained continuously at a maximum high average value.

Ancient Oil Engine Maintains High Efficiency

By J. H. Bender*

There is an impression among some engineers not well versed in internal-combustion engineering that it is only the modern oil engine that can give a good account of itself. While it is true that wonderful improvements have been made in the last fifteen years in the design of oil engines, a modern Diesel will show a thermal efficiency only slightly higher than will some of the old designs, and there are many plants using old engines whose operating records compare favorably with the newer plants.

For comparison with the results obtained by some of the small modern Diesel plants, the following data on a plant equipped with an old design of oil engine may be of interest.

The power-plant equipment of the Clayton (N. M.) Municipal Water & Light Department consists of two 90-hp. oil engines belted to 75-kva. alternators installed in 1911 and one 180-hp. engine belted to a 125-kva. alternator installed in 1916. These three engines are horizontal, single-cylinder, four-stroke-cycle machines of the semi-Diesel type, having a cylinder compression of approximately 275 lb. per sq.in. and using air injection, with ignition assisted by a hot bulb.

The generators are 2,300-volt, three-phase 60-cycle alternators, the two 75-kva. machines having belted exciters and the 125-kva. machine a direct-connected exciter. The switchboard consists of three alternator panels, one voltage regulator panel and four feeder panels. A watt-hour meter on the switchboard registers the entire plant output, but no instruments are installed for registering either the kilowatt-hour output or the fuel consumption of each individual unit.

The following brief summary is from the plant report for October, 1923, and is quite typical of average conditions.

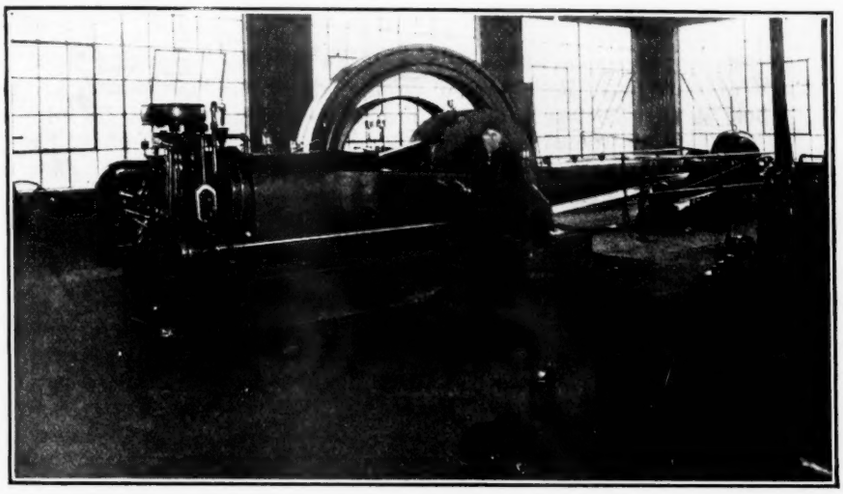
Total plant output, kilowatt-hours	44,260
Fuel consumption, gal	5,092
Engine-cylinder oil consumption, gal. ...	65.5
Bearing-oil consumption, gal.	27
Hard oil and cup grease, lb	7
Kw.-hr. output per gal. of fuel	8.69

The load conditions in this plant are not particularly good, being such that for fully three-fourths of the time the engines in use are operating below 70 per cent of rated capacity. The fuel used is a 22 to 34-deg. gravity gas oil, but fuels as heavy as 24 gravity have been successfully burned at various times. In comparing the fuel consumption of this plant with modern installations, it should be remembered that these engines are all belted to their alternators and that one of these belt drives is far from good.

The lubricating-oil consumption is larger than in a modern plant. New oil is used exclusively on the engine cylinders, the drainings from the crank cases and bearings being filtered through a De La Vergne oil reclaimer and then used for shaft bearings and similar purposes. An appreciable amount of the oil charged against the plant is also used for motors and pumping machinery of the water system located in the same building.

Usually, the reclaimed oil drawn from this reclaimer is in excellent condition, far superior to that purified by most processes, but once in a long time for some reason there is a failure in reclaiming a batch and it must be run through a second time. Undoubtedly, this is caused by improper handling of the equipment. The reclaimed oil comes off with its original color very nearly restored.

The reclaimed oil goes back into the gravity oiling system supplying lubrication for the engine shaft, crank and piston-pin bearings. The engine builder recommends the use of reclaimed oils for any purpose on the engine, but in this plant it has not been used for cylinder lubrication for the following reason. A considerable amount of bearing oil is needed for other purposes around the water-department equipment, this oil being about the amount of the surplus reclaimed oil that accumulates by adding new oil exclusively to the oiling system through the engine cylinders. By this practice better lubrication of the plant machinery is obtained, since by the addition of some new oil regularly and the removal of a similar amount of reclaimed oil from the system, the lubricant will not deteriorate to the extent that might be expected if used over and over without withdrawing.



De La Vergne type F.H. oil engine in Clayton plant

No difficulty whatever has ever been experienced in the parallel operation of the alternators. For over a year the current has never been off the switchboard busbars. This the engineers in charge of the plant consider a good record, since it must be remembered that with this type of engine from 10 to 15 minutes is required to start up an idle unit and connect it to the line. It is true there have been some shutdowns due to minor engine troubles in this time, but none in the nature of a breakdown that has caused an interruption to electrical service.

From Jan. 1, 1923, to Oct. 31, 1923, the expense for all repairs in the plant, including engines, alternators, exciters, belting and switchboards, has been $523.70.

*Superintendent, Clayton (N. M.) Municipal Light & Water Dept.

Coal-Storage Systems for Large Plants

THE demands now being formulated by the United Mine Workers for presentation to the bituminous mine owners will undoubtedly be resisted by the operators. Just what the outcome will be is impossible of prediction, but there are many indications that a strike will occur in April. The careful power-plant executive will protect his plant from a shutdown by taking steps toward the storing of a supply of coal before it is too late.

While the important plants already have coal-handling equipment, there are thousands whose equipment is worn out, obsolete or inadequate, and the number of plants where no storage facilities exist is equally great. Equipments suitable for small and medium capacity plants were discussed in *Power*, Jan. 8, 15 and 22. For larger plants the necessity of reclaiming is on a par with that of storage, and the system to be used must provide for the handling of the fuel from storage to the boiler-room coal bunker.

The Bridge Tram

A system largely employed on docks when an immense tonnage of coal must be unloaded from cars to the ship's hold in the shortest possible time, is the bridge tramway. This, as indicated in Fig. 1, consists of a structural steel bridge supported upon two movable *A*-frame supports. A clamshell bucket picks up the coal from the car and moves it to the unloading point, in

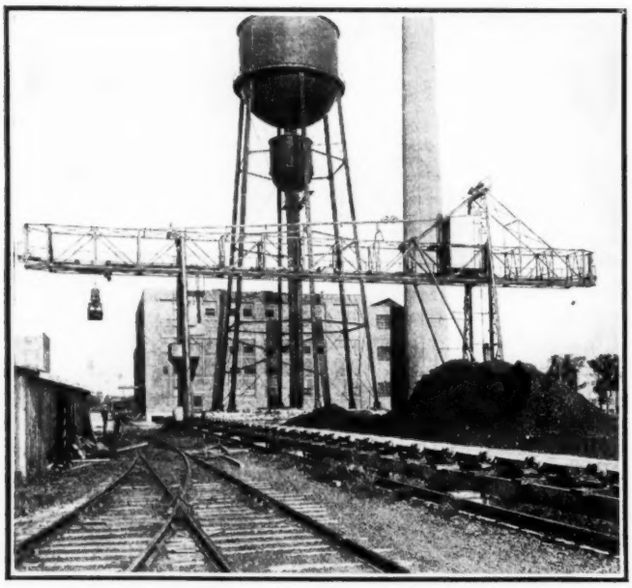


Fig. 1—Bridge tram for coal handling

Fig. 1 this being the storage pile. The clamshell may be suspended from a trolley carriage, as in Fig. 1, with the control house stationary at one end of the bridge, or, as is frequently the case, the control house including the electric hoisting drums moves along the bridge, the bucket being suspended directly below the cab.

The grab bucket picks up the coal from the car and moves to the right until it is over the storage, whereupon the bucket latch is loosened, the coal dropping onto the pile. When the coal piles up, the two *A*-frame levers are moved along their tracks so that a new storage ground is under the bridge. To recover the coal the clamshell picks up the fuel from storage and

Fig. 2—Cableway system is very flexible

drops it into a hopper, from which point it flows through a chute to the conveyor belt.

The tonnage of coal handled per hour depends upon the experience of the operator and the capacity of the clamshell. For plants where the storage is a considerable percentage of the total tonnage burned, this system is very popular.

The chief objection raised against the design is that the storage must have its greatest dimension parallel with the track if the bridge length is not to be excessive and costly owing to the greater span. Since it is usual to find track frontage more valuable than inside property, close consideration should be given to all the cost elements. The wide adoption of the bridge tramway indicates that its merits outweigh its disadvantages.

A somewhat similar system employing a single I-beam track instead of the bridge has been used in a number of plants. The bridge is expensive and can be replaced by a single beam of suitable section. The carriage wheels engage the upper sides of the lower flanges in the same manner as the small trolley hoist.

Cableway Has Broad Field

The cableway system, Fig. 2, might likewise be characterized as a modification of the bridge tramway, whereby a cheaper construction is made possible although the speed of unloading is decreased. The cableway system, while modified by the various builders, consists essentially of a fixed tower adjacent to the operating mechanism, a movable tower placed at some distance and mounted on wheels, a cableway, a grab bucket and control ropes.

Where the coal is received in cars, either of two methods of unloading may be followed. A sloping bottom hopper may be excavated under and to one side of the railroad track. The coal is dropped into the bin from hopper cars and then lifted by the clamshell bucket. By the second method the clamshell lifts the coal directly out of the car. This entails the time of one man to clean up the corners of the car.

The clamshell is attached to the hoist rope or cable which passes through a carriage carried by the cableway. After the bucket is dropped on the coal, the hoist is started, and since the carriage is held fixed on the cableway by a dog or stop, the rope lifts the bucket until the bucket head strikes the dog, releasing the carriage from the stop and holding the bucket to the carriage. Since the outer or movable tower is lower than the head tower, the carriage will run out along the cable as fast as the hoister man allows the hoist drum to unwind. When the carriage strikes a second stop placed over the coal pile, it is locked fast and the bucket released so that the latter can descend and be opened, or it can be opened while in the air by a hand latch rope. When empty, the bucket is elevated by the winding of the hoist drum until the carriage is struck, whereupon the carriage and bucket are pulled toward the lever until the first stop is reached. The carriage is held here and the unwinding of the rope allows the bucket to drop into the car or hopper.

Using Scraper to Reclaim Coal

In reclaiming, the coal is taken from the storage and moved along the cableway to the boiler room or bunkers. This system has many attractions. The movable outer tower permits a large storage in the shape of a pie section. The cost of the equipment is not excessive, for the parts are few and of simple design. Only one hoisting drum is needed and may, therefore, be nonreversing; any single drum hoist is suitable. The system is fairly speedy. In one plant a cableway replaced

Fig. 3—Cable-operated scraper moves coal to skip

9 men who worked 10 hours per day, a labor saving of $45 per day, enabling the outfit to pay for itself in labor saving in less than one year.

The ground scraper system, Fig. 3, has been quite successful in plants where 15,000 tons or more is carried in storage yearly. This system consists of a scraper operated by a hoist so that coal dumped from cars may be dragged away from the track. When the coal is to be reclaimed, the hoist connection is reversed so that the scraper drags the coal toward an elevator or similar apparatus, which moves the coal into the boiler-room bunkers. In Fig. 3 the switch track is placed on a trestle, the coal being dropped under the rails. The scraper is shown placed to drag the coal to a skip hoist which is to elevate it into the coal crushers.

Trestles are expensive and entail hand shoveling to some extent. To overcome this objection the drag

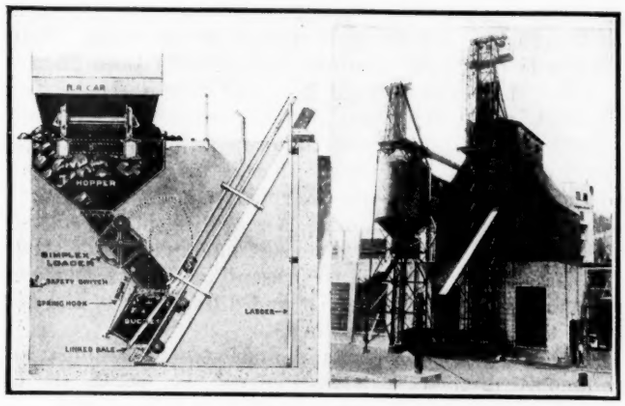


Fig. 4—Skip hoist in connection with scraper

scraper system has been designed in connection with a track hopper and skip hoist as in Fig. 4. The coal is taken out of the track hopper by a skip hoist which elevates the coal to the top of a tower from which it is chuted down onto a pile at the edge of the storage. At the right the skip hoist drops the coal into the bunker house, where it is either put into the bunkers or chuted down to the edge of the storage, and the scraper moves it to any desired place within the limits set by the guide posts.

In reclaiming, the coal is scraped into the track hopper and the skip hoist lifts it and drops it into the bunker house.

A drag scraper system to handle 60 tons per hour will not exceed $15,000 in first cost and the operating cost per ton of coal handled will average 3 cents. Such a system, save under exceptional circumstances, is not suitable for plants using less than 15,000 tons of coal per year. It has the advantage of storing the coal uniformly, and since fires are due to the presence of air in a pile, the packing effect of the scraper serves, by excluding the air, to eliminate the fire danger.

The results of 36 combustion tests made on a 4,680-sq.ft. water-tube boiler fired with pulverized coal at the power station of the Milwaukee Electric Railway & Light Co., Milwaukee, Wis., are given in Bulletin 223, just issued by the Bureau of Mines. The tests were made by the fuel section of the Bureau of Mines in co-operation with the makers of the pulverizing equipment. Illinois coal was used as fuel. The object of the tests was to obtain authoritative results of the performance of pulverized coal under various conditions of furnace operation and with coal of different fineness and moisture content. The results of the tests show that in this plant an over-all boiler efficiency of 80 to 83 per cent was obtained.

Impulse and Reaction in Steam Turbines

By FRANCIS P. HODGKINSON

BOTH the steam engine and the steam turbine use the available heat of the steam. The turbine utilizes it in increasing the velocity or kinetic energy of the jet; the steam engine utilizes it for producing certain pressure-volume changes within a cylinder. The thermodynamic problems encountered in the steam turbine are centered in the nozzle, where all the heat transformations theoretically take place.

After the jet has issued from the nozzle, the problem becomes a dynamic one; namely, to convert the jet's kinetic energy into power that can be delivered by the shaft as mechanical work. In this article we are not concerned at all with the thermodynamics of the heat-energy changes in the nozzle, nor are we concerned with the dynamics as applied to correct blade design. Rather, it is the author's desire to present in a clear and conclusive manner the principles and differences of the two main types of steam turbines.

The types of both water and steam turbines are commonly divided into two general classes, known by the terms impulse and reaction. One authority states that without further explanation the use of these terms might prove very misleading, as practically all commercial types of turbines today operate both by impulse and reaction. Long usage, however, has determined the accepted meanings of these terms, and it is useless to try to change them.

THERE is little connection between the real meanings of the terms reaction and impulse and the senses in which they are applied to steam turbines today. The author illustrates these various conditions and how applied to turbines. A succeeding article discusses the changes in pressure and velocity taking place in various types of steam-turbine stages.

By impulse we mean a force acting in a "forward" direction, and reaction is a "backward force, relative to the direction of the original impulse and equal to it in magnitude.

In Fig. 1 a tank with water is shown, from which issues a jet through a nozzle and impinging upon a flat block mounted on a carriage. As a result of the pressure due to the jet, the carriage will obviously be moved to the right.

In turbines it is best to regard as reaction only the force developed as a consequence of the generation of velocity at the expense of pressure in the *moving* element, hence we shall not regard the reaction force on the tank in Fig. 1. It is quite evident that here we develop no force that we can apply directly to the moving element as available power.

Fig. 2 shows the same tank of water with an issuing jet, mounted on a carriage. The pressure on the tank walls at the nozzle depends upon the height or head of the water above that point. With the water escaping from the nozzle there is no resistance at that point to pressure, and the unbalanced force exerted on the walls opposite will move the tank in the direction opposite to that of the escaping jet. The greater the pressure the greater the velocity of the jet, which, being transformed to kinetic energy of the jet, creates a greater reaction on the tank.

The significance of impulse and reaction as applied to turbines is shown in Fig. 3. Here the jet impinges against the curved surface of a wooden block on a carriage, and before it leaves this surface it is turned back upon itself through an angle of 180 deg. The block is therefore acted upon by two forces, both tending to move the carriage to the right. When the jet first strikes the block, an impulse force tends to move it, and when leaving, there is acting in a "backward" direction a reaction equal to the impulse. If the jets represented by Figs. 1 and 3 have the same velocity and density, the carriage speeds the same, and frictional losses neglected, the pressure on the block in Fig. 3 will be twice that on the block in Fig. 1.

Figs. 4, 5 and 6 are intended to show the application of impulse and reaction to steam turbines. In Figs. 4 and 5 *A* represents an expanding nozzle in which steam is expanded from boiler pressure down to some lower pressure, thereby acquiring high velocity and kinetic energy. In Fig. 6 *A* represents a stationary row of blades which perform the same function as the nozzles.

The steam ahead of the nozzle or its equivalent has potential energy or energy of pressure, which, as it expands in the nozzle, pushes the steam ahead of it forward. The energy generated by this expansion produces greater motion in the stream, transforming the potential energy to kinetic energy of the jet. This kinetic energy is then absorbed in moving the rotating element.

In Fig. 4 the blades have single curvature and the steam flows through the blade passage *B* without being turned back upon itself; that is, the blades have a curvature of less than 90 deg. If the wheel were held stationary, the steam would escape from the blade passages practically parallel to the axis of the shaft. The only force the jet can exert on the wheel is impulse, and the construction shown typifies a pure impulse turbine.

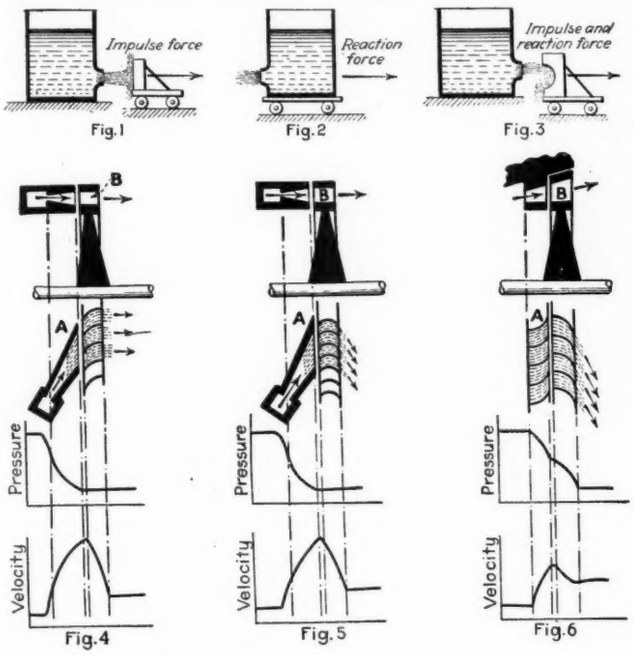
If, as in Fig. 5, the blades have double curvature, although the blade passage *B* is otherwise the same, the jet will be partly turned back on itself, a reaction force will be produced, and both impulse and reaction will be at work. A blade that turns the steam through less than 90 deg., like the one on Fig. 4, exerts only about half as much turning effort to the shaft as one that turns the steam through about 180 deg., as in Fig. 5.

Fig. 6 shows that type of wheel which in practice would be called reaction. Note first the change in the blade form as compared with the two previous forms. But the main change lies in the fact that the blade passage *B* allows the expansion of the steam while passing through it. The stationary blading *A* is so designed that only a part of the expansion occurs in it, the remainder down to back pressure occurring in the passage *B*, as is shown by the steam-pressure line in the diagram.

The steam is accelerated in passing through the stationary blades; the issuing jets are then retarded

by coming in contact with the moving blades, to which they surrender part of their kinetic energy. While passing between these latter blades, it is further expanded and issues from them with a reaction. Thus the moving blades receive energy by both impulse and reaction.

A reaction turbine has no nozzles, the steam entering the admission chamber or space with practically



Figs. 1 to 6—Movements produced by impulse and reaction

Fig. 1—Impulse forces movement in the direction of moving fluid. Fig. 2—Reaction produces movement against the direction of flow of the fluid. Fig. 3—Impulse and reaction, with regard to initial and reversed direction of flow, both produce movement in the same direction. Fig. 4—Pure impulse. Fig. 5—Impulse and reaction. Fig. 6—Impulse and reaction.

no velocity. From this space it enters the stationary blades, where it expands and attains some velocity as the pressure drops. As there is a continuous drop in pressure through the stationary and moving blades, partial peripheral admission of the steam as in the types just described is impractical. Steam must be admitted around the entire circumference of the wheels, and therefore the stationary blades must extend around the whole circumference.

The operation of a turbine depends upon the kinetic energy of the steam jet, and this energy is a direct function of the velocity of the jet, which, as stated before, depends on the expansion. Thus, it is seen that expansion is necessary in order to allow the steam to do work, and expansion cannot take place unless there is a pressure difference.

In the first two types the expansion takes place in the nozzle, and the jets cause the wheels to rotate by impinging on the blades in Fig. 4, and impinging and being thrown backward from the blades with some velocity relative to the blade speed in Fig. 5. If two pressure gages were connected to the entrance and exit sides of each of these two wheels, the gages would show the same pressure, as there has been no expansion through the blade passages.

In Fig. 6 the kinetic energy of the jets is transferred to the wheel and a further expansion takes place in the moving blades, which causes the velocity of the jet to increase, hence creating an additional kinetic energy available for producing mechanical work. If pressure gages were placed on each side of this wheel, the exit side would show a pressure less than the entrance side owing to the drop in pressure necessary for the expansion in the blades.

According to the preceding descriptions the wheel shown in Fig. 5 is an impulse turbine and that shown in Fig. 6 is a reaction turbine, but note that both these wheels really operate by both impulse and reaction.

As these terms are used today, there is really little connection between the usual meaning of the words and their connection to steam turbines. More appropriate terms are employed by a German writer when he uses the terms "gleichdruck" and "umgleichdruck," meaning "equal pressure" and "unequal pressure."

It is evident that the main distinction between impulse and reaction turbines as termed in practice, lies in the fact that in the first type no expansion of the steam occurs in the moving blade passages, while in the latter type it does take place.

Some Experience with a Two-Valve Non-Condensing Unaflow Engine

By Marshall L. Barker

A 26x30-in. unaflow, designed for condensing service, but with a hand-operated valve to connect in a larger clearance volume, which would permit the engine to run non-condensing in case the vacuum was lost, had been running non-condensing continually. Upon taking an

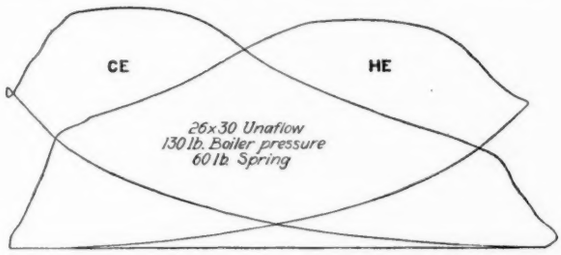


Fig. 1—Unaflow-engine diagrams showing late admission

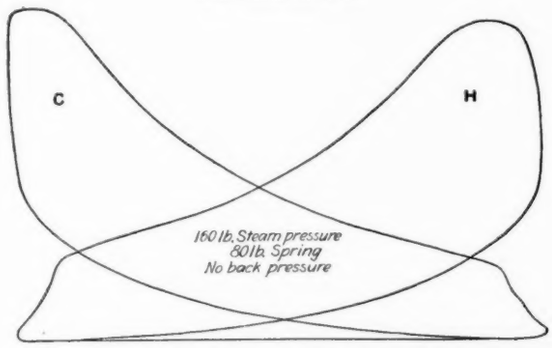


Fig. 2—Diagram after raising the boiler pressure

indicator diagram, Fig. 1, it was found that the steam valves were opening too late and the engine was very much overloaded.

To increase the capacity and economy of the engine, it was decided to raise the steam pressure to 160 lb., as both the engine and the boilers could stand it without distress. This resulted in a diagram as shown in Fig. 2.

At times, when operating under these conditions, however, there was a decided pounding in the cylinder. By holding a wrench on the rod it was found that the piston and tailrod were being lifted, the lift being about $\frac{1}{16}$ in. On closer examination the imprint of the oil grooves from the tailrod slipper could be seen on the guide at the head end of the stroke.

It was discovered that the piston over-run part of the steam port, which was at the bottom of the cylinder, and the rush of steam through the port when the valve opened, caused so much unbalanced pressure to be exerted on the lower half of the piston as to raise both the piston and the rod against the top of the cylinder. What kept it up there cannot be said, but at any rate the

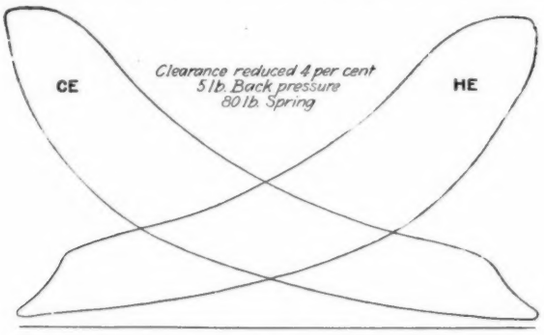


Fig. 3—Result of decreasing the clearance

slipper did not wipe out its oil-groove imprint for at least 14 in. of the stroke from the head end. The crank end did not lift because the main crosshead slippers held it down. The portion of the piston exposed over the port was $7\frac{3}{4}$ in. wide and $2\frac{1}{4}$ in. long.

To decrease the amount of this difference in pressure between the end of compression and the top of the diagram, it was decided to reduce the clearance 4 per cent, or down to 14 per cent. The clearance space around the cylinder formed a well at one end into which 240 lb. of melted lead was poured. There were some 3-in. openings through which the lead was poured.

At the bottom of this space was a $\frac{3}{4}$-in. pipe tap to drain off condensed steam when starting up. In order to keep this line open without tapping a new opening higher up, an insulated wire was run into a hollow covering of insulation material about $\frac{5}{8}$ in. in diameter and this in turn wound with insulation material to about $\frac{3}{4}$ in. diameter. It was then pulled through the $\frac{3}{4}$-in. hole and out the 3-in. opening and was held in place while the lead was poured. The wire was easily withdrawn, but the hollow insulation material had to be eaten out with acid and blown out with steam, leaving an opening down through the lead.

The engine then ran quietly and gave the diagram shown in Fig. 3. The tailrod slipper marks were entirely wiped out each stroke. With straight non-condensing operation the compression was nearly up to boiler pressure and the piston did not lift.

The 4 per cent clearance was found by assuming an exponent of 1.05 for compression and laying it out on logarithmic paper, which is done very easily and does not involve any equations with fractional exponents.

When soldering brass to lead, clean the lead and tin the brass; use tallow as flux and muriatic acid for the lead. Use copper cleaned with sal ammoniac, and tinners' solder.

Steam Boilers

A Catechism by Warren Hilleary Served in Small Doses and Extending Over a Number of Issues

32. What is grooving?

The cutting action generally found running longitudinally with the seams and immediately adjacent to the inner edge of the seams. It is generally caused by the bending action due to temperature changes and occurs oftener in lap-riveted seams than in butt seams.

33. What is galvanic action?

A chemical action not unlike electroplating. It is a wasting away of the material in some part of the boiler and the depositing of this waste in the water.

34. What is corrosion?

The wasting away of the metal by oxidization. It is generally caused by moisture and air coming in contact with the metallic surfaces.

35. What is crystallization?

The becoming inactive of the molecules of the material. This inaction causes a condition which, when the metal is broken, presents a granular appearing surface, and crystallization has the effect of making the metal brittle. In boilers it most frequently appears under the surfaces that are exposed to the hottest gases and is more prevalent in steel than in iron construction.

36. What protective measures may be used to prevent pitting?

Neutralizing the chemical action by the introduction of other chemicals; also by coating the exposed surfaces with non-corrosive agents, such as plumbago, crude petroleum, graphite and kerosene, or graphite and any other suitable retaining body which will not have too great a tendency to float to the surface of the water and cause an accumulation of oil at the water line. It may also be retarded by the introduction of zinc plates, but only under certain conditions, so this practice is not generally followed.

37. What protective measures may be used to prevent grooving?

There is no protective measure. When grooving is encountered in a boiler, the boiler should immediately be condemned even though the groove apparently extends only a short distance.

38. What protective measures may be used to prevent galvanic action?

No undisputed method has been discovered. Devices intended to retard the action by setting up counter-emf. have been advocated and tried, but these have not received favorable recognition in the technical journals.

39. What protective measures may be used to prevent corrosion?

Keep external surfaces clean; permit no moisture to accumulate and allow no valves or pipe connection to leak onto the surfaces.

40. What protective measures may be used to prevent crystallization?

No protective measures in boilers. Annealing may be resorted to in objects that can be properly handled.

41. Why are circumferential seams usually single-riveted while double or triple riveting may be necessary for the longitudinal seams of the same vessel?

The force acting to rupture the longitudinal seam is proportional to the radius of the cylinder. The force acting to rupture the girth seam is proportional to half the radius of the cylinder. Thus the force acting to separate the girth seam is half that acting to separate the longitudinal seam.

Dust on the Instrument Case

POWER PLANTS were never intended to be mechanical museums where unused equipment commemorates the happy ideas of the owners. Yet how often they fit this description! Passing through such a plant, one sees the exhibits on every hand. Here is a draft gage disconnected and covered with dirt, or perhaps giving foolish readings because the zero has never been adjusted. Over there is a pressure recorder whose inkless pen perpetually scratches invisible lines on a year-old motionless chart. In another corner rests a CO_2 recorder out of adjustment—covered with dust—as dead as old "Tut" himself as far as useful service is concerned.

The presence of these instruments shows that the engineer is a man of ideas—good ideas. A draft gage can do wonders for the man who must control a fire. The CO_2 machine on the job can save a heap of coal. With its clear records the recording gage stifles a thousand arguments and excuses. The installation of these and other instruments showed initiative as well as ideas. But there was no "follow through," not even the small amount of persistence needed to keep a well-designed instrument adjusted and in satisfactory operation.

So there they stand—museum specimens, nothing more—and they tell a story that any executive can read whether he understands the art of power production or not. The purchase of these instruments, he muses, was made on the recommendation of the engineer. Now they are shut down. That can mean only one of two things. Either they are of little value, in which case the engineer showed ignorance or bad judgment in the original purchase, or they are still capable of good work, in which case the engineer is advertising to all the world that he lacks the gumption to keep his plant in good working order. It must be one or the other of these conclusions—both equally damning.

The engineer who has thus fallen from grace has still a chance to retrieve himself. Let him place first on his schedule the duty (and pleasure) of putting every instrument in the plant in first-class working order. Then let him definitely assign to some member of his staff—or to himself if the plant is small—the daily task of keeping them so. Having once started clean, a few minutes each day will suffice to make necessary adjustments, wipe off the dust, change the charts and keep the pens full of ink. Then, and only then, will self respect return, coal bills go down and prestige go up. Nothing is so harmful to both the users and makers of instruments as instruments out of order for lack of simple every-day care. Nor is anything more beneficial to all concerned than the continuous savings that arise from their proper use supplemented by an intelligent interpretation of what they show.

Draft-Tube Design a Disputed Question

THERE have been greater developments in the design and application of draft tubes to hydraulic turbines during the last five years than in all their previous history. It is now generally realized that to obtain the highest efficiency, the turbine, intake passages and draft tubes must be designed as a unit. Where tests are made on models to check up on a design for a given installation, they should include the complete turbine and draft tube. Unless this is done, the full-size turbine may fail to come up to the results obtained from the tests on the model if the runner only is tested, as used to be common practice.

After a great deal of experimental work the question of correct draft-tube design is still a controversial one. No two sets of hydraulic-development conditions are alike, and a design that would be satisfactory for one type of wheel and setting might not be suitable for another. In a low-head installation where twenty-five to thirty per cent of the total energy in the water, represented by the difference in elevation between the forebay and tailwater, is in the discharge from the runner, the efficiency of the turbine is dependent to a large extent upon the efficiency of the draft tube. In the high-head plant using reaction-type runners, the energy in the discharge is small compared with that represented by the total head on the wheel. In such installations it would be difficult to find the difference in turbine efficiency due to the difference in the design of accepted types of draft tubes. However, it is of great importance that the water be led away from the turbine with a minimum of disturbance so that surging will not be set up in the draft tube, which may cause vibration in the turbine. It has been found by experience that the draft design has a marked effect in preventing turbine vibration.

There is also the effect of the relation between the axial and whirl components of the discharge to be taken care of in the draft tube. These components vary not only with the specific speed that the turbine is designed for, but also with the head and gate opening. Another factor that must always be contended with is the limited space in which the tube must be constructed. If the draft tube could be extended down without limit, it would probably take the form of a gradually expanding passage similar to the discharge end of a venturi tube. With the space restrictions encountered with the average hydro-electric plant, this must be done in a comparatively short distance.

Given such wide variations in conditions as may affect the design of a draft tube, it is not surprising that a diversity of opinion exists as to what is the best design and will exist until present developments have had time to crystallize by further experimental work and practical experience. Since the efficiency of the

large-capacity mixed-flow turbine has been raised to over ninety per cent for more than half its load range there can be little improvement effected in this direction in draft-tube design except in very low-head plants. Therefore the greatest gain must be made in reduced cost by simplifying the design, establishing the design as a more exact science and assisting in preventing unfavorable hydraulic conditions in the turbine. In this direction there are opportunities for further advancement in the art of hydraulic-turbine design and operation.

Haste Undesirable When Erecting Turbo-Generators

THERE may be some diversity of opinion as to whether haste or comparative leisure is to be preferred in the erection and starting of steam-turbine units. However, disregarding whether it is advantageous to hurry matters or not, these things are quite often determined by those who are not directly connected with the actual work of erecting.

The new unit may be urgently needed for carrying load, and with this end in view every energy may be bent toward as early a start as possible. Other conditions, such as a specified date for completion or the desire to "turn over" before a competitor's machine is started, may also be used as a lever to spur along the erector.

Small sets which are shipped completely assembled, may require from two hours to two weeks as a period of preparation for service. Where there are no adjustments to make, a little haste is not likely to endanger the unit. As sizes grow larger, however, the processes required of the erector become more involved, important and deserving of painstaking accuracy.

Generally speaking, accuracy is imperiled in proportion to the amount, beyond normal, of haste uniformly applied. Speed of accomplishment should not mean hurrying through important operations. A little urging may be advantageous, but many ill-advised moves have directly resulted from undue haste, and particularly as a sequel to pressure unwisely applied.

In an extreme case we may visualize the conditions obtaining when it has been found necessary to cut the usual time for the erection of a large unit in half. Here, work would proceed both day and night, with plenty of experienced men on hand. In dividing the duties otherwise personally handled by the man in general charge, there would be more opportunities for a "slip" to occur. Alignment and clearance operations would in some degree be made at night, where disadvantages of artificial light, unnatural working hours and a nervousness due to the desire to "get through" must certainly militate against reliable results. Placing a cap on the wheel casing or cylinder is another delicate process where care is essential. Although frequently accomplished in "overtime," it is nevertheless an exacting piece of work. Search for foreign objects in the machine must be absolutely sure. Haste in this operation is seldom allowed.

Starting up for the first time is usually a momentous event. A certain dramatic interest naturally attracts visitors. As a matter of fact, bringing the turbine up to speed and trying under load should be the sole concern of the erecting and operating forces, from one point of view. If trouble is encountered, it may be remedied without unnecessary comment and adverse exaggeration, which frequently otherwise results. If good operation ensues, distinguished visitors may then be invited to a carefully staged trial, with the chances of an embarrassing situation eliminated in advance.

A large unit, however, represents an integral part of a large capitalization. It owes its existence primarily to an industrial need, and secondarily to the commercial processes of financing, buying, and selling. It is not always necessarily under the complete jurisdiction of the erecting department.

Where the interests of the general public or of smaller groups make it desirable to apply pressure in matters of this kind, discrimination should be used to see that this is wisely and carefully guided, in order that the results may be beneficial rather than detrimental to the interests of all concerned.

Sentiment Shifts Regarding Muscle Shoals

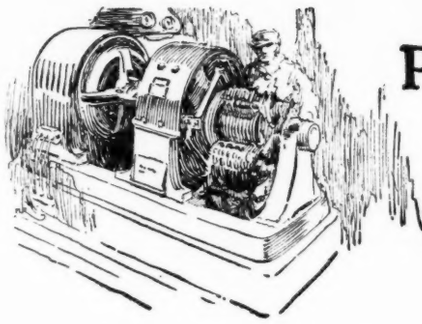
MUSCLE SHOALS is again to the front in the deliberations of Congress, and there are indications that the decision may be made with due regard to the political fortunes of the committee personnel regardless of the merits of the various offers and the benefit to the government as a whole.

There was a time, early in the negotiations, when the Ford proposal stood out as the best of the offers that had been received by the government. At that time, however, the prevailing sentiment in Congress was not favorable to Ford. Strangely, Congressional opinion seems now to have completely reversed in spite of the fact that the Ford offer has remained practically the same, while others more attractive have been received. The latest offer by the Associated Public Utilities would net the government several hundred thousand dollars a year more than Mr. Ford's proposal, or an aggregate of over thirty-seven million dollars in fifty years. Moreover, it would still leave the government free to dispose of the nitrate plant to Mr. Ford or anyone else on the best terms obtainable and would guarantee to supply, at cost, sufficient power for the operation of the nitrate plant for the manufacture of fertilizer.

Apparently, the manufacture of fertilizer is only one of Mr. Ford's objectives, although a very attractive one to the agricultural group. Ostensibly, he has in mind the building of a large industrial works in the locality of Muscle Shoals. As an industrialist he is generally admired and commands confidence. Moreover, the people of Alabama look kindly to the establishment of a Ford enterprise within the boundaries of their state.

It will be recalled that President Coolidge, in his message to Congress early in December, suggested that authority be granted for the appointment of a committee having the power to dispose of Muscle Shoals upon the most advantageous terms obtainable. Stripped of sentiment or political color, this would be the business-like way for the government to handle the matter. There is little likelihood, however, of Congress relinquishing any prerogative that could be turned to political advantage from a sectional viewpoint.

A manufacturer is often judged by the impression his engineering salesman makes upon the customer. Aside from selling ability it is essential that the engineering salesman be well grounded in fundamentals and at least know more about his product than the customer.



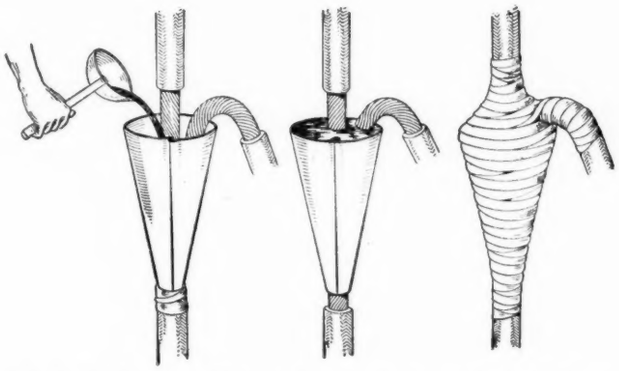
Practical Ideas *from* Practical Men

How Motor Cables Were Connected Quickly in an Emergency

Some time ago the company with which I am connected was asked by the city authorities to assist them in supplying water to the city main owing to a breakdown in their pumping station.

Our pumping equipment consists of two 8-in. centrifugal pumps direct-connected to 75-hp. motor. When the plant was installed, for some reason only one starting compensator was provided for the two motors, which were connected to it by a double-throw switch. Owing to this arrangement only one pump could be operated at a time.

When we were asked to furnish water to the city, it so happened that one department of the mill, in which there was a 125-hp. motor, was idle, so we moved the starting compensator of this motor into the pump-



Method of connecting motor leads to main feed lines

house and transposed the leads of No. 2 motor from the double-throw switch to it while No. 1 pump was operating. All the necessary connections except the final tapping of the feed lines were made before No. 1 pump was shut down. As it was necessary that this connection be made with as little delay as possible and no tee connections were available, we decided to use the method shown in the illustration.

Three funnels were made from sheet iron, leaving the seam open with hook edges. When everything was in readiness, the switch was opened on the feed lines and the connections hurriedly made. The insulation was removed from the feed cable for a few inches and the funnels were formed around them. After sealing the small end and the seams of the funnels, the ends of the leads from the starting compensator were bent into a hook and hung in the funnels, which were then filled with molten solder and finally insulated by wrapping with varnished cambric and friction tape. About a week later, when the city no longer required our assistance to maintain the water supply, the compensator was moved back to the mill and the ends of the cable were tapped up.

A. A. FETTE.

New Iberia, La.

Where Should the Water Be Discharged in a Return-Tubular Boiler?

The point at which the feed water is discharged in a return-tubular boiler is, I believe, much more important than the majority of engineers realize.

In some boilers the feed pipe enters through the shell, near the front head, and is carried about halfway back with only an elbow on it. This allows the feed water to be discharged directly on the top of the tubes, causing a deposit of impurities on them.

Another method is to continue the pipe from the elbow down through the tubes and let the water feed onto the shell in the bottom of the boiler. Now the heat is greatest at the bottom of the boiler, and if the water contains a considerable percentage of impurities, damage is likely to result to the plates at this point.

It seems to me that if a pan were placed at the end of the feed pipe, it would tend to prevent the impurities from getting onto the shell. There are water-tube boilers in which pans are used, and I see no reason why it could not be used to advantage in return-tubular boilers.

Possibly some readers of *Power* have had experience along this line and could point out the advantages or disadvantages of pans in the boiler for this purpose.

San Jose, Calif. R. E. GRAVES.

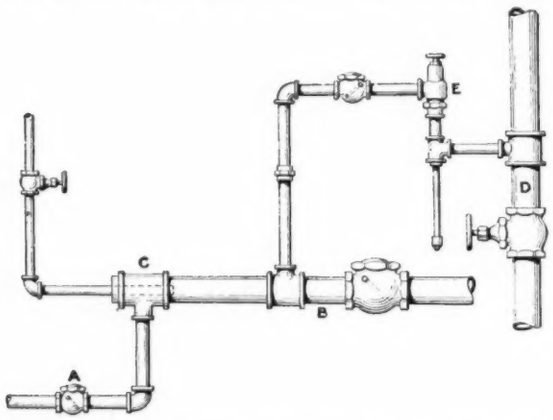
Disposing of Sediment Preventing Excessive Pressure

One of my high-speed engines is fitted with a separate pocket in which sediment collects. This comes from the stuffing box on the piston rod and from an oiler that drops cylinder oil on the rod. At first a large pail was placed under the engine-room floor and used to catch this drip, but it was inconvenient.

By way of an improvement suitable piping was installed to discharge this to the main blowoff pipe. Owing to conditions it was necessary to make this pipe 26 ft. long with seven turns. There were two check valves in it, to prevent sediment from blowing back on the engine when the boilers were blown down under pressure. This action caused oily sediment to collect in the pipe, and it was a disagreeable job to clean it out. To overcome this, the device herein described was installed: The illustration shows the sediment pipe and one check valve at *A*. This discharges into the

main pipe at *B* through the tee at *C*. A bushing is screwed into this tee, carrying a small pipe, connected to a globe valve. The valve admits water under 80 lb. pressure, thus creating a sucking action in *A*, and keeping the pipe clear at all times.

The vertical pipe *D* is used to fill the boilers with cold water, hence it contracts a considerable amount as the pipe is long. This pipe is fitted with tight valves at



Special piping removes sediment and relieves water expansion strain

both ends, consequently when these are closed and the pipe subjected to the heat of the boiler room, it expands and creates a high pressure. To relieve this automatically, the small safety valve *E* was installed. It discharges through the check valve as shown. Of course only a small quantity of water will relieve the pressure, but this action is a safeguard against bursting the pipe. W. H. WAKEMAN.

New Haven, Conn.

Items To Remember in Oil-Engine Plants

The degree of hardness of the circulating water is a matter that should have careful study when designing the layout of a Diesel station. Should the natural means of obtaining rain supply be inadequate, a waste-heat boiler installed on the exhaust pipe line will supply enough steam to make up the reserve supply.

The chemical softening plants are now made in such capacities that any size of plant can be equipped with this type of softener, and although the first cost is rather high, the upkeep is very low. The main water-supply piping should be provided with duplicate strainers to prevent a stoppage of the branch connections to the water-cooled pistons and exhaust valves.

The next matter to be considered is the air supply. If the engine room is situated in a dusty location, the air should be supplied through dust filters and the compartment built into the general layout of the building. Should the air supply be drawn direct from the engine room, a dustproof tile or a well-painted concrete floor should be provided and no dust allowed to accumulate in the room.

In the case of small engines this dust problem to a certain extent may be taken care of by covering the slots in the suction pipe with several layers of fiber matting. This not only filters the air, but silences the air suction.

The lubricating-oil filtration system should receive careful consideration, being made large enough to permit the thorough clearing and extraction of all impurities. The carbon, water and other impurities can be removed by a centrifugal or gravity filtering system, either of which will be found of advantage and will greatly reduce the lubrication and general repair costs. Should the oiling system be of the gravity type, the overhead supply tank should be of sufficient capacity to enable the engines to be kept in operation some hours in case a breakdown occurs on the oil-pumping equipment supplying this tank from the filtering system.

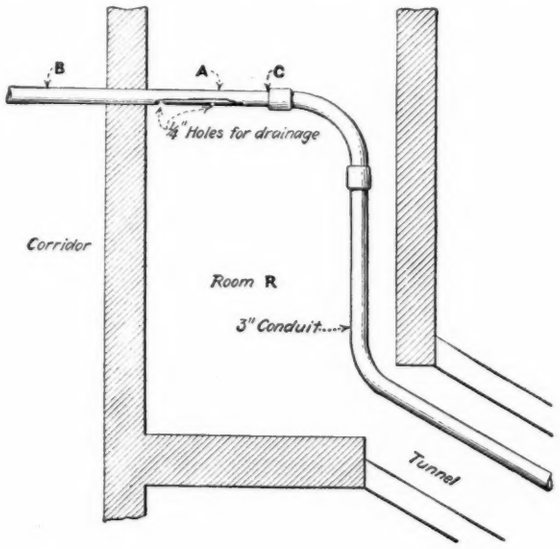
New York City. H. T. MELLING.

Removing Moisture from Conduit Eliminates Grounding

On taking charge of the power department of a sanatorium, one of the first problems encountered was the continual grounding of the 440-volt three-phase power supply main, on the 3-in. conduit in which it was carried. We replaced the cable and conduit several times only to have it ground again.

The trouble was finally located in a section where the 3-in. conduit led out of an underground tunnel in which all the steam, hot-water and cold-water supply lines, the respective returns, telephone and power lines were carried from the power house to various points for distribution.

Referring to the illustration, the 3-in. conduit passed up from the tunnel through room *R* and out into a corridor. Inasmuch as the room *R* was closed, it was warm at all times from radiated heat from the lines in the tunnel. The corridor, being open and well ventilated,



Holes in bottom of conduit provide drainage

was much cooler. Consequently the conduit had "sweat" and moisture collected at *A*, this being a low point in a sag between *B* and *C*. Therefore moisture had collected and finally resulted in grounding the cables on the conduit.

The trouble was remedied by replacing the ruptured cable, and by drilling about six ¼-in. holes along the bottom of the conduit between the points *B* and *C*. This provided means for letting out any moisture collecting in the conduit. E. S. BEE.

Sanatorium, Miss.

Comments from Readers

Eye Protector for the Fireman

In the article entitled "Eye Protector for Firemen," in the Jan. 15 issue, the author states that after trying several different types of goggles he found that a green celluloid eye shade gave excellent results. It appears to me that an eye shade made of celluloid is the last thing that should be used by a fireman working close to a boiler. Since celluloid is inflammable his eyes and face would be in danger.

We have found that the best protection for a man's eyes when working at heating furnaces is a fine copper wire cloth. This is made sufficiently large to protect the man's face as well as his eyes. It is bound with leather around the edges, and the fireman fastens the top edge of the screen to the front of his cap. Perhaps this screen does not protect the eyes quite so well as goggles, but it does cut down some of the glare and keeps the man's face cool.

These face guards are the only ones that have given satisfaction to the men in our works.

E. C. KIRKPATRICK,
The Steel Company of Canada, Ltd.
Montreal, Canada.

Boilers and Boiler Auxiliaries

Referring to the Jan. 1 issue of *Power*, under the heading "Boilers and Boiler Auxiliaries," you state that the integral economizer, owing to corrosion difficulties and poor circulation and heat transfer, is giving place to the counterflow steel tube unit.

My experience in helping to develop one type of an integral economizer would hardly warrant the statement quoted. It is true that corrosion difficulties developed in some cases because the water was not deaërated. This condition, however, was speedily recognized and as you stated further on in the article mentioned, deaërating equipment must be supplied with all types of steel-tube economizers.

We realize that integral type economizers have been failures because no provision was made for the circulation of the water which results in stagnation in certain parts and corrosion. Also with very slow water speed, the heat transfer is low.

These objections can be and have been overcome by proper gas baffling and arrangement so that the water level in the preheater gives a natural gravity circulation just as in the boiler. With the counterflow the speed of the water is low and is not as thorough as with a natural gravity circulation. Moreover, it is not necessary, with a natural gravity circulation, to provide bypass dampers for the gases, as it is with the counterflow type.

With the preheater, in the case of an emergency stop in the feed water, the economizer can steam just like the boiler and will not steam-lock or cause water hammer, as will the counterflow type.

Therefore, we are able to obtain maximum results with a great deal less heating surface, and with a less heating surface necessary, because of better water circulation, the draft loss is just about one-third that of the counterflow type, which cuts the power consumption of the induced draft fans almost in half.

J. H. ROHRER,
Philadelphia, Pa. Phillips Badenhausen.

What Becomes of the Ash with Pulverized Coal?

In the Dec. 18, 1923, issue of *Power*, an abstract from a paper by H. D. Savage, entitled "What Becomes of the Ash with Pulverized Coal?" is given on page 1007. He asks "What becomes of the ash?" and says that he personally has been too busy to attempt to follow it up, and as it has not seemed of particular interest to any of the neighbors of pulverized-fuel plants, either near or far, he can see no reason why a certain element who would not use powdered coal under any condition can so concern themselves with this discussion.

Then he gives a concrete example in which he says in part: "If 29 per cent of this ash is emitted from the stack it makes about 30 tons of ash in 24 hours." After an attempt to minimize the effect of this ash upon the earth, he informs us as follows: "You must perceive that the resultant particles of ash are infinitesimal, and inasmuch as a study of these particles when isolated under an ultra-microscope reveals them to be never stable, it must be assumed that none but the heaviest of them ever fall to the earth until they are precipitated by moisture. This theory is borne out by the fact that, except in one instance, none of the very earnest investigators has ever been able to discover the resting place of any of the ash emitted from the stacks, at either Milwaukee or Detroit."

Now the conclusions of Mr. Savage as outlined in this article may be justified from his point of view, considering the earth and power plants only, but serious-minded engineers see something more important than power plants. Invisibility of the ash is not an assurance of its harmlessness, and some engineers see the possibility of this ash lodging in places more sensitive than the ground, with grave possibilities to human life, not to mention the indirect effect of solid impurities in the air or health.

Respiratory organisms of human beings are an ideal extractor of this floating ash from the air, and the broadcasting of thirty tons of invisible ash, or about 3,000 cu.ft. of dry ash, to the four winds each day, is surely of no small importance to the surrounding territory.

Now, it is neither foolish nor a joke to inquire, "What becomes of the ash?" nor does it matter to us who does or does not use pulverized coal, but serious-minded men or engineers cannot be convinced that tons of fine floating ash in the air is not a menace to the health of a community. It would be better for all concerned to face the fact and realize the importance of

safeguarding the public health, and not depend too much on the invisibility of the ash, due to its size, escaping detection. A man in a public-service plant, or a corporation serving the public cannot afford to jest about such a serious subject as the public health. Men and corporations serving the public are in duty bound, first of all, to safeguard the public health, and this important function cannot be evaded.

Chicago, Ill. HENRY MISOSTOW.

Phasing Out Alternating-Current Generators

Referring to the discussion on E. C. Curtis' letter on "Phasing Out Alternating-Current Generators," I suggest that he complete the installation work up to making the connections to the generator oil switch at the switchboard, having the engine ready to run, and then call in one of the service men of the company that made the generator. This man could in a day and at very little expense, check all the connections and show how to synchronize the machines and make adjustments to obtain the best parallel operation. It would be possible to write a description of the phase-out and synchronizing procedure, but an expense of fifteen to twenty dollars for an expert's service is a small premium for the assurance that everything will operate properly.

For the general information of Mr. Curtis, it might be said that the simplest way of phasing out a generator is to connect a motor, as in Fig. 1, to the present generator, note which way it runs, and then connect it to the corresponding leads of the new generator switch (the switch being open), build up voltage on the new machine and see which way the motor starts. If it runs in the same direction, the sequence of the phases is correct; if not, two of the generator leads must be interchanged the same as to reverse a motor. In choosing corresponding connections to which to connect the motor, the poles of the switch which will connect to the same busbar are to be taken and not what might appear to be the corresponding connections on the generator itself.

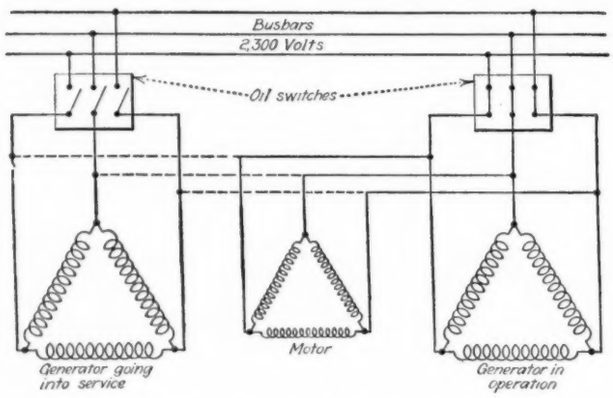


Fig. 1—Connections for phasing out generators

It is quite possible to synchronize alternators with lamps only, but this is not so convenient or quick as with a synchroscope, as the lamps give no indication of which unit is running the faster. The lamp connection shown in Fig. 2 is simple and practically foolproof except against burning out of lamps. Considering the cost of a synchroscope, if the units have to be paralleled once a day or oftener, it is a good investment to install both it and the lamps, and never throw the switch to parallel the machines unless the indications of both are normal and consistent. I have seen a synchroscope with a broken ground connection give an indication of coming slowly into phase that would have led to throwing in a machine completely out of phase if it had not been for the check indication of lamps.

The best place to install an indicating wattmeter to obtain the total load is with current transformers in the bus between the generator panels and the distributing section of the board and with the meters own potential transformers tapped directly off the busbars. As there are only two units, the arrangement of a voltmeter permanently connected on each will be satisfactory, though if another is added, one voltmeter should be permanently connected to the busbars and the other arranged with plug receptacles for each unit, so as to indicate when they are up to the proper voltage for synchronizing. A good rule for work of this kind is to remember that parallel operation is not a mysterious affair, but is governed by the common-sense electrical rules. If a thing does not appear reasonable, don't do it until you are satisfied why it should be done.

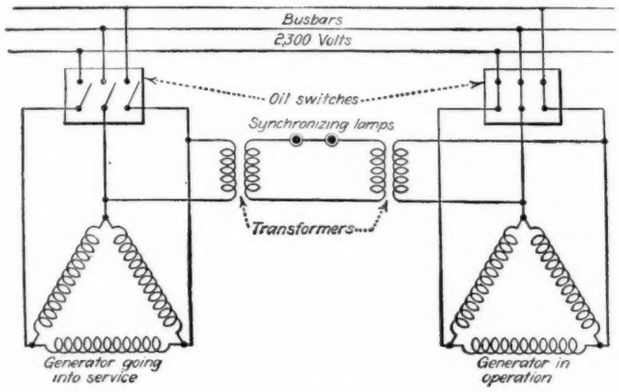


Fig. 2—Synchronizing-lamp connections; lamps dark when machines are in phase

New Haven, Conn. H. D. FISHER.

The Throttling Calorimeter

In looking through the Dec. 25 issue of *Power* I noticed with much interest an article on "The Throttling Calorimeter," by Thomas M. Gunn. It has always seemed to me that Prof. Cecil H. Peabody, now Professor Emeritus of Naval Architecture of Massachusetts Institute of Technology, received insufficient credit for having developed a simple instrument that really marked an epoch in an important piece of engineering work. Anybody who has ever used the old barrel calorimeter which preceded Peabody's instrument will, I think, agree with this statement. It happened that I was doing a lot of testing for the Babcock & Wilcox Co. about the time that the throttling calorimeter came into use, and I have always felt grateful to my distinguished kinsman for the brilliant idea that he devised and gave to the world without any string. I think his original paper was presented before the A.S.M.E. about 1888.

George H. Barrus devised a throttling calorimeter made up of pipe fittings and somewhat easier to con-

struct than Peabody's. He also used two thermometers and offered the suggestion that a radiation correction not only was necessary but could be easily made by making the so-called calibration test with the stop valve of the boiler closed. In doing this, he contributed a good deal to the art, but the big idea belongs to C. H. Peabody.

The point of this letter is that in Mr. Gunn's article no credit is given to Professor Peabody, notwithstanding the fact the instrument shown in the illustration is almost an exact duplicate of Peabody's.

I note also that Mr. Gunn finds a little difficulty in applying the word "calorimeter" to an instrument that measures "the amount of moisture in the steam or in other words to determine the steam quality." Too many people forget that the words "saturated steam" mean steam saturated with heat, not with water. My old chief, William D. Hoxie, now president of the Babcock & Wilcox Co., called my attention to this years ago, and I think it is a point that is overlooked by the technical schools in their instruction of young engineers. I have talked with a number of young men lately, and they are all pretty hazy about what the word "saturated" means as applied to steam. I am wondering what Mr. Gunn thinks about this.

I did not intend to discuss this article at quite so much length, but the subject is an interesting one, and I do feel that Professor Peabody did something that the engineering world has failed adequately to recognize. It has certainly saved many a weary hour for testing engineers and has led to much greater accuracy in a very important subject. If Professor Peabody's method had been more complicated, it might have received more notice.

ERNEST H. PEABODY.

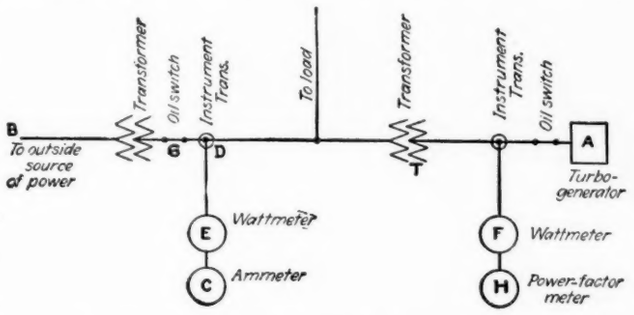
New York City.

Parallel Operation of Generators with Purchased Power

Victor H. Todd interestingly describes in the Nov. 20, 1923, issue a problem concerned with the metering of power in a plant that is tied in with an outside source of power. I believe that an error has been made in the calculations and the interpretation of the cause of the observed readings. A case is described in which an 80 per cent power-factor load is supplied from two sources. It is stated that if the kilowatt component of this load is equally divided between the two sources of supply, the power factor on the line from one source of supply being kept at 100 per cent, the power factor on the other will be 60 per cent. According to my calculations this power factor will be 55.5 instead of 60 per cent.

Circuits are also described, which, for the problem considered, are equivalent to those shown in the one-line diagram. The following condition is described:

With generator *A* adjusted so that the power-factor meter *H* shows unity power factor, wattmeter *E* indicating zero load and ammeter *C* indicating the wattless current supplied by the outside source of power, switch *G* connecting to this outside source of power is suddenly opened and it is observed that the kilowatt load on the turbine is increased. Mr. Todd explains that the increase in load on the generator is due to the increased I^2R losses that result from the increase in current taken by the motor load when the voltage is reduced due to the demagnetizing of the alternator's field. This explanation assumes that there is no change in the generator field current. I believe that the increase in the generator load is mainly caused by the increases in resistance losses due to the changed circulation of the wattless current. Before the line switch is opened, generator *A* is furnishing the I^2R power loss caused by the reactive current in the part of the circuit on the load side of the instrument transformers located at *D*. When switch *G* is opened, the reactive current is forced to circulate through transformer bank *T* and generator *A*. The reactive current will be approximately the same, if not greater, in this case. The power that is required from the generator to cause the circulation of the wattless current will be greater, since the generator is required to supply the I^2R losses in the entire circuit instead of a part of it, as was the case previous to opening the switch. Of course, as shown by Mr. Todd, if the generator voltage decreased when the switch was opened, there could be



One-line diagram of generator, transformer and load connections

an increase of I^2R loss due to the increased power current resulting from the reduced voltage. This would hardly be the case, because even if there were no voltage regulator on the generator, the voltage would in all probability be brought to normal by hand if opening the switch caused it to fall appreciably.

Mr. Todd tells of a case where a station load of 11,000-kw. was reduced to 9,800 kw. by increasing the power factor from 70 to 100 per cent. This would indicate that the I^2R losses with the 70 per cent power factor were 2,350 kw. or 21.4 per cent, which seems to be rather large. He does not say how the power factor was brought up to unity. It would make a great difference how this was done. If the load was all or nearly all synchronous motors, a much greater saving could be effected by bringing the power factor to unity by changing the fields on all these synchronous machines than would result if the low power factor was due to induction motors and was brought up to unity by the placing in service of a synchronous condenser. In the latter case the I^2R losses due to the circulation of wattless currents in the induction-motor circuits would still exist even if the condenser were installed near the motors. In the case of synchronous motors the current in the motor circuit would be reduced when the power factor was changed from 70 to unity, and a reduction in the I^2R losses in these motors' circuits would be effected in addition to the reduction of the losses in the lines and transformers between the load and the power station. The use of sychronous motors is to be preferred for power-factor correction when they can be applied.

JAMES SPRAGUE.

Marietta, Ohio.

QUESTIONS AND ANSWERS

Conducted by Franklin VanWinkle

Ethyl-Chloride Refrigerator

We are considering the installation of an ethyl-chloride refrigerating machine. While the unit is small, some doubt has been expressed as to the suitability of this refrigerant in a hospital. Will it explode if exposed to a flame? W. L. C.

If ethyl chloride of an amount equal to from 4.9 to 13.5 per cent be mixed with air, an explosive mixture is formed. It is possible by mixing the ethyl chloride with methyl bromide to eliminate the fire risk, as the mixture is non-inflammable and will even act as a blanket to destroy a fire. The refrigerating qualities of the mixture are not far different from those of the pure ethyl chloride.

Variation of Lead in Automatic Engines

In an automatic shaft-governed engine how does the lead change from no load to full load? J. C.

In most automatic engines the eccentric is swung across the shaft to vary the cutoff by varying the throw of the eccentric and thereby vary the travel of the valve. The variation of the throw of the eccentric is obtained not by moving the eccentric in a straight line across the shaft, but by swinging it around a pivotal point. This causes variation in the angular advance of the eccentric, with variation of the lead, and the point of suspension is so located as to obtain increase of the lead with increase of the fraction of cutoff, using such proportions in the design of the valve gear that, as far as possible, sufficient lead to prevent pounding at no load will not cause excessive lead at full load.

Steambound or Airbound Pump

How does a pump become steambound or airbound, preventing it from taking water? W. L. G.

When the pressure of the suction water is not sufficient to follow up the piston with water during a suction stroke, a space of less pressure is formed by displacement of the pump plunger or piston. In handling hot water, when the pump suction pressure thus becomes as low as the pressure of vaporization corresponding to the temperature of the water, the pump cylinder during a suction stroke and also the pump suction chamber or even the suction pipe, may become filled with steam to the exclusion of suction water, and when this occurs the pump is said to be steambound.

Most water contains some air or other gases that are liberated by reduction of pressure of the water. When the pressure of the suction water is reduced by displacement of the pump piston or plunger during a suction stroke, more or less air is liberated from the water in the pump cylinder, suction chamber and suction pipe. In place of being discharged along with the water, the liberated air may form aggregations of small bubbles that adhere to cavities or rough surfaces of the suction pipe and parts of the pump chamber or water cylinder. When such accumulation of air is sufficient to prevent flow of water, the suction pipe or pump in which the obstruction occurs is said to be airbound.

Water-Regulating Valve for Ammonia Condenser

Is it necessary to use any particular type of regulator to control the flow of water to the condenser in connection with a compressor to keep the pressure constant? W. J. P.

Any form of pressure-regulating valve may be used, but no part coming in contact with ammonia should be made of brass. The chamber above the diaphragm is connected with the condenser so that any increase of ammonia pressure will cause the main valve of the regulator to open wider, increasing the flow of water over the condenser coils. A regulator of the kind will operate more satisfactorily on a one-stand condenser than on multiple stands, owing to variation in action of the several stands. A regulator on each stand will correct the difficulty.

Changing Speed of Corliss Engine

How can we change the speed of a simple Corliss engine? T. P. L.

Most Corliss-engine governors are provided with means for varying the dead weight that is used to balance the governor. Increasing the dead weight required to be lifted by the centrifugal force of the governor balls causes the speed of the engine to be increased, since the cutoff will not take place until a higher speed has been attained. On the other hand, reducing this dead weight permits the governor to assume a position for effecting cutoff for slower speed of the engine and governor.

However, it is not advisable to change the r.p.m. in this way more than 5 per cent above or below the normal speed, as it may give rise to irregularity of the engine speed. For a greater change of engine speed there should be a change of the relative speed of the governor and engine. Causing the governor to run slower with respect to the speed of the engine would permit of higher engine speed before the governor would be brought to the position for effecting cutoff, and therefore the engine speed would be increased by placing a larger receiving pulley on the governor or a smaller governor driving pulley on the engine shaft. Conversely, to obtain regulation with less r.p.m. of the engine, speed up the governor with respect to the engine by a smaller governor receiving pulley or supply a larger governor driving pulley. In either case, change

the diameter of pulleys in the same ratio as the change desired from the speed that is obtained with normal loading of the governor. If the pulley sizes are thus selected with reasonable care, there will be only moderate variation from the desired speed which can be compensated by varying the loading of the governor. But before undertaking to speed up a releasing-gear Corliss engine, trial should be made to determine whether the valve gear will operate at the proposed speed and it should be known whether the flywheel and other parts are adapted to the proposed speed.

Choice Between Low Grades of Coal

Which rice-size coal of the following analyses could be considered better for steaming purposes?

	Sample A		Sample B	
	As Received	Dry Basis	As Received	Dry Basis
Moisture, per cent	6.02	.....	6.98	.....
Volatile combustible, per cent	7.04	7.50	5.28	5.60
Fixed carbon, per cent	65.42	69.62	68.92	74.10
Ash, per cent	21.50	22.88	18.88	20.30
Sulphur, per cent	.....	1.42	.....	1.39
B.t.u.	10,810	11,500	10,416	11,200

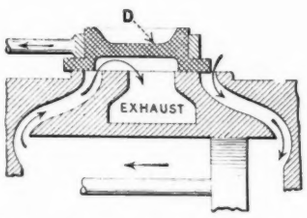
How many B.t.u. per pound should be contained by a rice size of coal of average good quality? W. E. R.

The high percentages of moisture and ash in each instance indicate that the coals are of poor quality, aside from the low B.t.u. per pound, which for a steaming coal should not be less than 12,500. Although the analysis of sample A shows somewhat higher B.t.u. than sample B, the latter probably will be found more profitable to use on account of containing a lower percentage of ash. The efficiency of combustion ordinarily decreases with increase of ash, and there is also the additional expense for coal handling and disposal of ashes. A coal containing 20 per cent of ash is 10 per cent less efficient in proportion to B.t.u. content than one containing one-half as much ash. The value also depends on the form in which the incombustible is present. If combined with the fixed carbon in aggregates, a stronger draft will be required and the efficiency of combustion will be lower than if the percentage of incombustible consists of separate pieces of slate or earthy material mixed with good coal.

Action of Pump Slide Valve

What is the difference between a slide valve of a duplex pump and that of an engine? H. L.

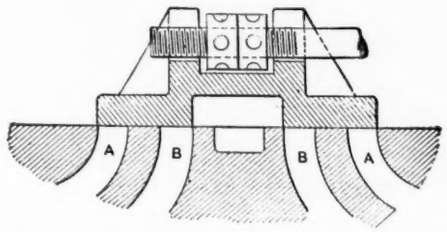
The slide valve of a duplex pump is like the slide valve *D* of an engine with outside admission, as shown



Slide valve and ports of engine

in section, Fig. 1. But for the engine, the cylinder is provided with only one port in each end of the cylinder. While the port at one end is uncovered for admission of steam, the port in the other end is in communication with the exhaust, as indicated by the arrows.

In a duplex steam pump the valve controls two ports *A* and *B*, Fig. 2, in each end of the cylinder. The lap and travel of the valve are such that the outside ports *AA*, Fig. 2, are uncovered only for admission of steam to the extreme ends of the cylinder and the ports *BB*, farther from the ends of the cylinder, are uncovered only for communication with the exhaust. This is to obtain cushioning of the piston as it nears the end of its stroke. The piston, in approaching the end of an exhaust stroke, covers an exhaust port *B*, and as the port *A* in the same end of the cylinder remains closed,



Steam slide valve and ports of duplex pump

the exhaust that is in the end of the cylinder when port *B* is closed, is compressed, forming a cushion to stop the piston before it travels far enough to strike the head of the cylinder.

Lap of Corliss-Engine Exhaust Valves

In a Corliss engine why is it not sufficient to obtain compression by simply giving lap to the exhaust valves? R. N.

When compression is obtained by adding lap to make the valve close earlier, it also would be opened later and would not be opened so wide. Consequently, there would be later release after expansion and higher back pressure during the exhaust period. When the exhaust valves are set without any lap, with the wristplate in its central position, and the eccentric and reach rods are of such length that the wristplate is moved as much to one side as the other of its central position, the eccentric set 90 deg. with the crank would cause release at the end of an admission stroke and closure of the exhaust without compression at the end of a return stroke. Then, by giving lap to the exhaust valve there would be earlier closure with some compression, but the release would not begin before the beginning of the return stroke. Early enough release might then be obtained by sufficiently advancing the eccentric, but unless the lap is very little, the correction for release usually would be accomplished by unnecessary back pressure during exhaust from insufficient opening of the valve, and probably there would be excessive compression.

The extent to which it may be desirable to acquire compression at the expense of release depends on the engine design and operating conditions. When enough compression and appropriate release cannot be obtained by merely setting the valves without lap and advancing the eccentric, it may be advisable to modify the relations of release and compression by adding lap to the exhaust valves. To obtain the best compromise, the valve setting should be guided by the use of a steam-engine indicator.

[Correspondents sending us inquiries, should sign their communications with full names and post office addresses. This is necessary to guarantee the good faith of the communications and for the inquiries to receive attention.—Editor.]

Here and There in the Power Plant

Sidelights on things generally used but less generally understood

A New Slant on Steam Pressures

IF A plant is running with a 28-in. vacuum and 100 lb. throttle pressure, it seems reasonable that an increase of initial pressure should reduce the consumption of both steam and coal for the same power output. There is, in fact, such a gain, but if the plant had been exhausting at atmospheric pressure, the gain by raising the throttle pressure would be relatively much greater.

A Live Question Just Now

This question is particularly timely just now because of the general interest which the engineering profession is centering on the subject of high pressures. With several plants being erected in the United States for pressures of 1,000 lb. or more, it is pertinent to ask how high it pays to carry the steam pressure. Like all matters in practical engineering this comes down to a question of dollars and cents. As the pressure is raised the fuel consumption decreases, rapidly at first, then more and more slowly, until at a pressure in the neighborhood of 1,000 lb. the gain practically ceases. This figure of 1,000 lb. represents a rough average of the results computed by various authorities for present-day conditions, the actual figures running all the way from 600 lb. to 1,500 lb. Along with this reducing fuel cost is a generally (but not always) increasing cost of construction, which requires a bigger and bigger yearly charge for interest and depreciation. For any given set of conditions it does not pay to raise the pressure above the point where the additional fuel saving by any further increase in pressure would be exceeded by the corresponding increase in fixed charges (interest and depreciation).

Simple Rule for Available Power

The discussion so far has dealt mainly with condensing stations. Many isolated plants operate non-condensing, using part or all of the exhaust steam for heating or process work. This condition greatly favors higher pressures. That this is so may be shown by studying the steam rates of various types of prime movers with various initial and final steam conditions. Such data, however, are difficult to obtain, particularly for high initial and back pressures. Another method of attack is to work out the theoretical steam consumption from the steam tables and then allow the actual engine a definite fraction of the efficiency of the theoretical. This article presents a simpler method that is remarkably handy for rough and ready calculation, although (like many rules of thumb) it is a rather crude approximation and should be so considered.

The rule is this: *For every drop to one-half the initial pressure (absolute) 1,000 lb. of steam per hour passing through an engine or turbine will produce 21 hp. (or 15.5 kw.).* Assuming that this rule is exact (which it is not) and assuming a perfect turbine, some interesting results can be deduced without difficulty.

Consider a plant in which the engine or turbine used develops a little less than one-half the theoretically available power from a given amount of steam. Then for each 1,000 lb. of steam passing through the turbine per hour, the power derived would be, say, 10 hp. each time the pressure fell to one-half its initial value.

What Pressure Is Needed?

Now suppose the plant has an absolutely constant demand for power and process steam, the power required being 600 hp. and the process steam 20,000 lb. per hour at 45 lb. per sq.in. absolute[1] pressure. By generating the steam at some higher pressure and expanding it in engines or turbines to 45 lb., power can be gotten out of the steam before it goes to the process. It is desired to find how high the initial pressure must be to get 600 hp. out of the 20 thousand pounds of steam per hour. Dividing 600 by 20, it is seen that 30 hp. must be obtained from each thousand pounds per hour. It has already been assumed that 10 hp. could be obtained by starting at any pressure and expanding to half that pressure. Conversely, if we start at any exhaust pressure and double it, we get the initial pressure required to produce 10 hp. This gives 90 lb. initial pressure. For an additional 10 hp. double again, getting 180 lb. initial pressure. For the desired 30 hp., double a third time, giving an initial pressure of 360 lb.

So it is clear that by carrying the initial pressure up to about 360 lb., the plant could get all the power it needs from the 20 thousand pounds per hour of process steam it must necessarily generate in any case. The extra fuel burned would total only about 180 lb. per hour, so the fuel cost of the power generated would be insignificant.

Suppose, with the same power and steam requirements, the desired process pressure were 100 lb. absolute instead of 45. Then, doubling 100 three times in succession, it is seen that the initial pressure would have to be about 800 lb. to supply all the power needed. In order to have the steam dry saturated at exhaust, it would be necessary to superheat the high-pressure steam something less than 100 deg. F.

Probable Development Along This Line

The average owner of a plant with these requirements, particularly the one involving 800 lb. steam generation, would doubtless hesitate before using such a pressure. Both the boiler and the turbine would have to be of special design and the cost of the boiler (under present conditions) would be high. In the case of the turbine the cost of special construction might be partly counterbalanced by the saving in weight due to the higher pressure. One could hardly blame the average industrial plant for hesitating about installing such an unusual outfit. Yet the proposition certainly appears logical on paper. The earlier stages of such development will naturally fall into the hands of the larger corporations who can afford to risk an experiment that promises so much gain. After operating difficulties have been solved and the construction of high-pressure equipment put on a manufacturing basis, it is reasonable to assume that the smaller concerns will fall in line.

In any particular plant the desirable pressure will of course depend on the relation between the steam and power requirements and upon the degree to which the two fluctuate up and down together. Where the two requirements do not keep in step, there may be an opportunity for the employment of the steam accumulator, a device that has been recently brought over to this country from Europe.

Rule Applies Over Wide Range

In reference to the rule just given, it should be noted that it may be used throughout the range from 15 to 1,000 lb. absolute, although the error may be considerable if the initial pressure is more than 20 times the exhaust pressure.

This rule is not intended to take the place of more accurate calculations. These should always be made before making any final decisions as to equipment and steam pressure. The method described will be very handy for preliminary scouting and for explaining the matter to non-technical executives.

After making closer calculations with the total heat entropy chart, it would be necessary to obtain actual steam rates on turbines or engines designed for the given conditions.

[1] As the rule given applies only to absolute pressure, all pressures throughout this article are absolute; that is, gage pressure plus 15 lb.

New Equipment

Valves for Pressures up to 1,350 Pounds

Owing to the increase in steam pressures used in large power plants and particularly in central-station development, the Crane Co., Chicago, Ill., has developed a new line of cast-steel valves and fittings for working steam pressures up to 1,350 lb. per sq.in. with the prevailing superheat.

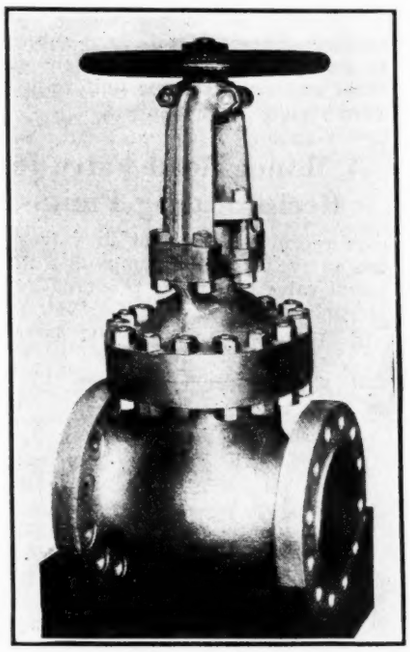


Fig. 1—Six-inch gate valve for 600-lb. steam working pressure

The company is using "Series" numbers to designate its various lines of cast-steel material: Fig. 1 shows the 6-in. gate valves, with outside screw and yoke, as made in Series 50, or for a steam working pressure of 600 lb.; a typical cross-sectional view is also shown in Fig. 2. These valves are recommended for superheated steam and hydraulic working pressures as follows:

Series Number	Superheated Steam Working Pressure	Hydraulic Working Pressure
15	150	300
25	250	350
35	400	550
50	600	800
75	900	1,200
150	1,350	3,000

These valves for pressures over 150 lb. embody several distinctive features in construction. The neck of the body at the bonnet end is practically circular in cross-section. This is a departure from the flat oval-shaped bonnet and has been done with a view to strengthening the entire valve by proportionately distributing the internal and casting strains. The bonnet gasket joint is circular and is machined with a male and female face to prevent gasket blowouts.

Referring to the sectional view in Fig. 2, projected bridge walls are cast in the body and the body rings are screwed into these walls. The use of the projected seat provides uniform sections of metal at this part of the body and eliminates the usual heavy section of metal at this point.

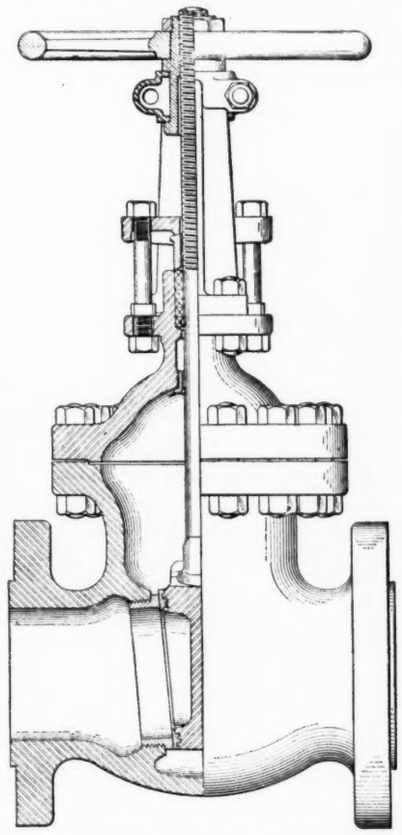


Fig. 2—Typical cross-sectional view of gate valve

The method of connecting the disk to the stem is by means of a tee-shaped head that is forged on the end of the stem and engages in a slot in the disk. This connection furnishes sufficient flexibility to permit the disk to seat without binding the stem. The disk is made with exceptionally long guides which are fully engaged with ribs in the body even when the valve is wide open or lying on its side.

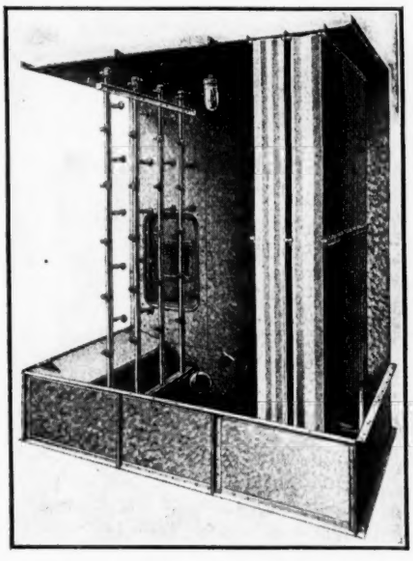
The stuffing box or packing space is sufficiently deep to permit a generous amount of packing. A pressure relieving chamber is provided under the stuffing box. A departure has been made in the design of the gland. It consists of two parts, a gland flange and follower, with a ball-joint bearing between them. This prevents the gland from binding on the stem when the bolts are not uniformly pulled up.

These valves are also furnished equipped with electric-motor control and with the welding lip on the end flanges for making up the Sargol joint.

Clarage Air Washer

A new air washer, for operation in public buildings and for industrial application, has been developed by the Clarage Fan Co., of Kalamazoo, Mich. The spray nozzles are designed so that a small disk guiding the incoming water to the side walls and specially shaped passages impart a whirling motion to the water, so that when it leaves the outlet orifice, the water is diffused to the extent that the spray measures 15 in. in diameter at a distance of 7½ in. from the tip of the nozzle. Each nozzle has a capacity to discharge 2 gal. of water per minute under the usual pump pressure of 20 lb. Nozzle-spacing over the washing chamber is in the ratio of three nozzles per 1,000 cu.ft. of air per minute.

The illustration shows the arrangement of the scrubber and eliminator plates, designed for removing the dust and other foreign matter as well as any entrained moisture. Their combined depth is 12¾ in., while the total amount of washing surface provided equals not less than 25.25 sq.ft. per 1,000 cu.ft. of air per minute. The use of detached lead spacers facilitates the erection of the plates over the older method of springing or forcing them into long notched angles.



Arrangement of scrubber and eliminator plates

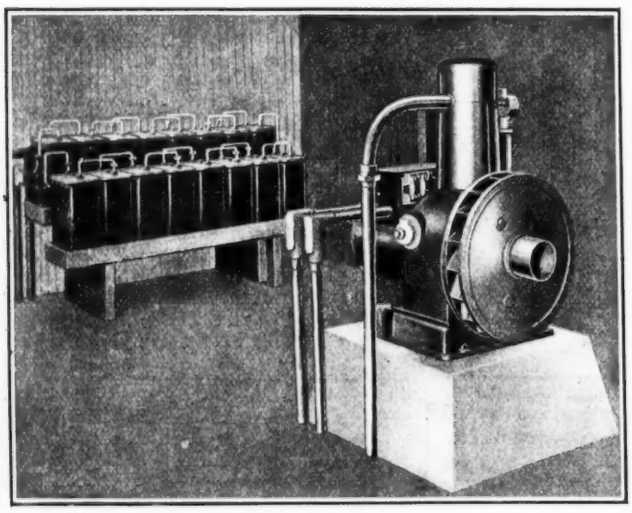
Flooding nozzles, not always necessary, are provided for certain types of work. The inspection door is held tight against the gasket by locking cams on all four corners. Pulling the handle away from the washer lifts the cams out of their notches, so that they can be swung to the side and the door is free to open.

Small 110-Volt Light and Power Plant

A small 110-volt direct-current light and power plant has been developed recently by the Westinghouse Electric & Manufacturing Co. The plant consists of a gasoline engine, 110-volt generator and control, also a battery.

The plant operates on gasoline, kerosene or natural gas and has been designed especially for supplying light and power services for farms, summer hotels, and in any locations where central-station service is not available.

The unit has been designed with a view to making it as simple as possible to operate. A hydrometer scale shows the number of hours the plant must be run to charge the battery properly. A dial is then set to the correct number of hours, and the engine is started by pressing a switch. When the time has elapsed, the engine is automatically stopped.



Unit mounted for operation

A 56-cell lead-acid battery is supplied with the unit and is made in two sizes, one of which has a capacity of 7,850 watt-hours at 8-hour rate and 11,150 at intermittent rate and the other 15,750 watt-hours at 8-hour rate and 22,265 watt-hours at intermittent rate. The batteries are of the glass-jar type and are equipped with perforated rubber-sheet separators protecting both the plates and the wood separators.

The engine is four-cycle with a bore and stroke 3⅜x5-in. Air for cooling the cylinder is supplied by a fan in the flywheel. The engine is lubricated by a splash feed system designed to supply an equal amount of oil to the moving parts, regardless of the depth in the crankcase. This is accomplished by an oil-carrying gear that dips into the oil in the crankcase and carries it to a pan, keeping the oil in this pan at a constant level. A six-gallon fuel tank is built into the base of the unit.

The four-pole generator, which is bolted to the engine frame, has a capacity of 1,500 watts, the armature being mounted directly on the engine shaft. The generator has a shunt winding, with a series field for starting the engine. A 3x5-in. pulley is built on the flywheel for supplying power by means of a belt.

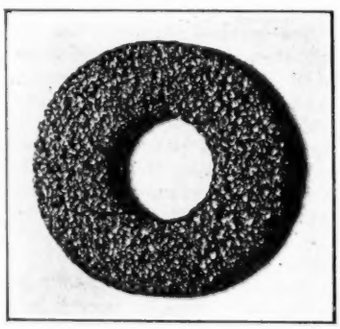
A New Metalastic Packing

If it were possible to pack the stuffing boxes on the piston rods of reciprocating engines, compressors, etc., with a liquid, it would unquestionably be the ideal packing, since it would be readily adjustable to worn and scored rods and, if installed on a new machine, would prevent wear from taking place.

A new type of packing in which an attempt has been made to embody some of the characteristics of a liquid has recently been developed by the Metalastic, Inc., 280 Broadway, New York City. Some of the features claimed for this packing are elasticity, constant state of molecular readjustment to changes in temperature without hardening, and adaptability to any size and style of stuffing box with equal effectiveness. The packing is an admixture of materials suitably combined to provide these properties. It is placed in the stuffing box small portions at a time and rammed tight, then compressed by drawing down the gland, more packing being added as required.

A New Type of Pipe Joint

A radical departure in flanged pipe joints has been brought out recently by the Granulated Metallic Joint, Pittsburgh, Pa. The process consists of granulating the contracting faces of flanges or fittings, giving a surface as shown in the illustration. The granulating is accomplished with simple tools, a flat surface on the flanges or fittings being the only requirement. In use the contracting faces are coated with a pipe-joint cement and the joint is then pulled up in the usual manner. The cement facilitates breaking the joint or line for repairs and functions as a flexible gasket.



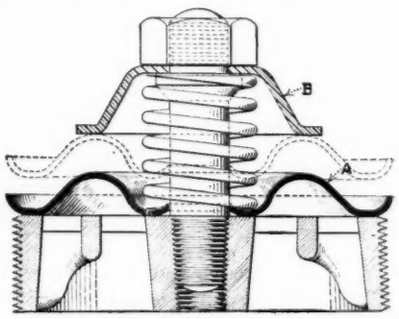
Granulated flange face

It is claimed that this joint can be broken as many times as desired without loss of efficiency and without further treatment of the surface except to add more cement if necessary. On a number of tests of this joint subjected to gases and fluids at different pressures and temperatures uniformly efficient results were obtained.

A Monel Metal Valve for Reciprocating Pumps

A recent development in valves for use in reciprocating pumps is a monel metal valve now being produced by the Durabla Manufacturing Co., New York.

A cross-section of the valve assembly is shown in the illustration with the full open position indicated by the dotted lines. It will be seen that the disk *A* has an arch design connecting the inner and outer seats. This design tends to give maximum strength with metal sufficiently thin to insure lightness, the latter feature removing the tendency to clatter and permitting the use of the valve in horizontal, inclined or vertical positions. The guard *B* performs a function not usually taken care of on this type of valve. It serves as a protection to the spring and also guards against strains on the disk *A* in case of overspeeding of the pump or lost suction, by limiting the lift of the disk.



Sectional view of valve assembly

Some of the advantages claimed for this valve are its resilient, rustproof and acid-resisting qualities and its adaptability for use with practically any liquid at any temperature and pressure, thus obviating the necessity of keeping in stock valves of various composition for use on the different services.

Correction: In describing the Republic Draft Gage in the Nov. 20 issue, the statement was made that this employed a new principle of draft measurement. This is incorrect, inasmuch as the same principle has long been employed in the Bailey meters.

Application of Various Types of Coal-Handling Equipment*

By George E. Titcomb†

THE necessity for storing greater amounts of both anthracite and bituminous coal is becoming more and more apparent if the coal yards, industrial plants and power plants are to be safeguarded against a coal shortage, and if advantage is to be taken of a low market price.

Our present immigration policy, the scarcity and high cost of labor, the demand on the part of the workman to be relieved of drudgery, and the desire on the part of employers to use the human element only at those points where intelligence is required for controlling the mechanical apparatus, have all tended toward a concerted effort to introduce this kind of equipment.

In designing coal-storage plants, consideration should be given to the kind of coal to be handled. Anthracite does not deteriorate when exposed to the weather, and there is little danger of spontaneous combustion.

Bituminous coal loses some of its heating value when exposed to the weather. This loss is less than is usually supposed and is not enough to make submerged storage necessary.

The deterioration is due to oxidation which produces heat. The temperature of the coal is kept within safe limits if there is sufficient circulation of air to carry off the heat, or if packed tight enought to prevent the air from coming in contact with the surfaces of the coal. An even distribution of the lumps and fine coal has a tendency to prevent heating by preventing air from circulating in the voids in the pile.

When coal is piled by the cone method by dropping from a single point, the lump coal rolls down the sides of the conical pile to its base, forming a pile composed of lumps at the base and fine material above. Dangerous heating is liable to occur because the air is freely admitted to the lumpy strata, while the fine coal over the top prevents the escape of heat.

Any system employed in the handling of coal should combine with mechanical simplicity the largest facility and economy. In selecting the machine best suited for any particular location, consideration should be given to the following underlying principles:

1. The equipment must show a profit on the investment. The ideal plant is that which does the work for the lowest cost per ton.

2. If it is to serve a development of temporary character, it should have a high resale value.

3. The area covered and the handling capacity should be capable of extension if required.

4. It should be designed to build the coal pile so as to avoid the segregation of the lumps and fine coal.

5. It should be capable of quickly removing heated coal from the pile so that it may cool.

6. It should have sufficient capacity over daily requirements to prevent demurrage of boats or cars.

The revolving locomotive crane is built in various sizes and can be driven by steam, electricity or by a gasoline motor. It travels on traction wheels, crawler treads, standard-gage tracks or wide-gage tracks. The revolving locomotive crawler tread crane may be shipped from the point of manufacture to the purchaser completely assembled ready for operation, with the exception of the boom and bucket, which can be quickly placed in position. It has a high resale value because it can be used for many purposes besides handling coal, and because it can be loaded on a flat car under its own power and shipped without dismantling. It can be operated by steam, electricity or a gasoline motor.

Coal can be piled to a height of 25 ft. with this crane (40-ft. boom) and it can travel to any part of the storage area without the use of tracks. If it is used to unload barges or cars, it can form a storage pile directly back of the machine and then travel to the rear of the pile and rehandle the coal so as to form a pile of any required depth. If the pile is reasonably level, it can ascend a 30 per cent grade to the top of the pile and dig out heated coal that cannot be reached from the yard level. The data for a typical machine of this sort are given in Table I.

TABLE I—DATA FOR REVOLVING LOCOMOTIVE CRAWLER-TREAD CRANE

Capacity	
Bucket capacity, cu.yd.	1
Radius of boom, ft.	40
Single line pull, lb.	6,000
Hoisting speed, ft. per min.	200
Rotating speed, r.p.m.	5
Traveling speed, ft. per min.	275
Grade up which it will travel, per cent	30
Rate of operation, cycles per min.	2
Average handling capacity per day of 8 hours:	
Bituminous coal, tons	400
Anthracite, tons	500
Cost of Operation (8-Hour Day)	
Capacity with average lift, tons in 8 hours	400
1 crane operator	$8.00
1 helper	5.00
Labor burden (150 per cent of labor)	19.50
1 ton fuel, at $6	6.00
Oil and water	2.00
Repairs and replacements	4.00
Interest on investment, 6 per cent on $9,500	1.90
Insurance and taxes, 3 per cent	.95
Depreciation and obsolescence, 6 per cent	1.90
	$49.25
Cost per Ton (Single Handling)	Cents
Operating	5.25
Burden	4.87
Maintenance	1.00
Interest and depreciation	1.19
	12.31

The revolving locomotive standard-gage crane is shipped on its own wheels from the point of manufacture, completely assembled, and can be made ready for operation by simply attaching the boom and bucket. It can be operated by either steam or electricity. It has a high resale value because it can be used for other work and can be transported without dismantling. Data for a typical crane of this type are given in Table II.

TABLE II—DATA FOR REVOLVING LOCOMOTIVE STANDARD-GAGE CRANE

Capacity	
Clamshell bucket capacity, yd.	1½
Radius of boom, ft.	50
Single line pull, lb.	8,000
Hoisting speed, ft. per min.	300
Rotating speed, r.p.m.	5
Traveling speed, ft. per min.	500
Drawbar pull, lb.	8,000
Rate of operation, cycles per min.	1½
Average handling capacity per day of 8 hours:	
Bituminous coal, tons	600
Anthracite coal, tons	800
Cost of Operation (8-Hour Day)	
Capacity with average lift, tons per day of 8 hours	600
1 crane operator	$8.00
1 fireman	6.00
1 helper	5.00
Labor burden (150 per cent of labor)	28.50
1½ tons of fuel, at $6	9.00
Oil and water	2.00
Repairs and replacements	5.00
Interest on investment, 6 per cent on $12,750	2.55
Insurance and taxes, 3 per cent	1.27
Depreciation and obsolescence, 6 per cent	2.55
	$69.87
Cost per Ton (Single Handling)	Cents
Operating	5
Burden	4.75
Maintenance	0.83
Interest	1.06
	11.64

The wide-gage revolving locomotive crane cannot be shipped assembled on account of its size. It must, therefore, be erected at destination. It can be operated either by steam or electricity. Its resale value is not as high as crawler-tread or standard-gage cranes. A crane of this type at the plant of the Dayton Light, Heat & Power Co. will pile coal 40 ft. high. The coal for storage is dug from the track hopper that also serves the power house, or direct from railroad cars located on tracks that parallel the crane runway. For reloading, the coal is loaded by the crane into railroad cars and dumped in the power-house track hopper. The figures for this crane are given in Table III.

An electrically operated cable drag scraper at the plant of the Solar Refining Co., Lima, Ohio, operates in a storage area 200 ft. long. The cable drag scraper will store to a depth of 40 ft. The equipment consists of a track hopper for unloading the railroad cars, a crusher under the hopper for crushing the coal before going into storage, an elevator and chute for forming a pile from which the scraper takes its load, and a haulage machine for operating the scraper. This system reclaims coal at the same speed with which it is stored, by reversing the action of the scraper which delivers

*Abstract of paper presented before the Metropolitan Section, A.S.M.E., Engineering Societies Building, New York City, Jan. 22, 1924.

†McMyler Interstate Company.

it into the track hopper through the crusher, after which it is elevated and delivered back to cars for transfer to the power plant. The data for an installation of this kind are given in Table IV.

TABLE III—DATA FOR WIDE-GAGE REVOLVING LOCOMOTIVE CRANE

Capacity

Bucket capacity, cu.yd.	5½
Boom radius, ft.	120
Single-line pull, lb.	11,000
Two-line pull, lb.	21,000
Hoisting speed, two-part line, ft. per min.	150
Rotating speed, r.p.m.	2
Traveling speed, ft. per min.	200
Rate of operation, cycles per min.	1
Average handling capacity, tons per 8-hour day	1,500

Cost of Operation (8-Hour Day)

Capacity with average lift, tons per day of 8 hours	1,500
1 crane operator	$8.00
1 fireman	6.00
1 helper	5.00
Labor burden (150 per cent of labor)	28.50
3 tons of fuel, at $6	18.00
Oil and water	3.00
Repairs and replacements	6.00
Interest on investment, 6 per cent on $45,000	9.00
Taxes and insurance	4.50
Depreciation and obsolescence	9.00
	$97.00

Cost per Ton (Single Handling)

	Cents
Operating	2.66
Burden	1.90
Maintenance	0.40
Interest and depreciation	1.50
	6.46

TABLE IV—DATA FOR A TYPICAL DRAG SCRAPER INSTALLATION

Capacity

Capacity of scraper, lb.	1,200
Speed of scraper, ft. per min.	350
Horsepower	25
Cable pull, lb.	1,800
Maximum depth of pile, ft.	40
Length of pile, ft.	200
Handling capacity in 8 hours, tons.	750

Cost of Operation (8-Hour Day)

Average haul, ft.	100
Capacity in 8 hours, tons	750
1 operator	$8.00
2 helpers for dumping cars	10.00
Burden (150 per cent of labor)	27.00
Current, at 1 cent per ton	7.50
Oil, etc.	2.00
Repairs and replacements	4.00
Interest on investment, 6 per cent on $15,000	3.00
Taxes and insurance	1.50
Depreciation and obsolescence	3.00
	$66.00

Cost per Ton (Single Handling)

	Cents
Operating	3.66
Burden	3.6
Maintenance	0.54
Interest and depreciation	1
	8.8

Plans French Connections for Corporation

The International Combustion Engineering Corp. announced recently that it is negotiating with French industrial interests for the formation of a new company to be partly owned in this country, for the designing, building and equipping of power plants. The corporation has just completed arrangements with Vickers, Ltd., for the formation of a new company to be known as Vickers, Limited, and International Combustion Engineering Corp., which will undertake this work in England.

Keeping the Refrigerating Plant In Continuous Operation*

By Halbert P. Hill†

IN REFRIGERATING plants interruptions to service must be avoided wherever possible. In plants employing high-pressure air agitating systems supplied by motor-driven air compressors, it is necessary to provide means to keep the air compressors running, and in some instances duplicate self-starting gasoline sets are installed. However, I do not recommend them on account of the possible complications and the additional equipment. A better method is to use an automatic starter provided with no-voltage release only and so arranged that this coil will not release unless the voltage falls to 50 per cent below normal. Should the voltage fall below 50 per cent, the starter would release, but immediately upon resumption of voltage it would automatically start up the motor again. This would provide for a minimum possible interruption. Careful tests have shown that for the average installation the motor will pull the compressor up to speed against full back pressure.

Other Equipment Should Be Similarly Arranged

Certain other equipment should be similarly arranged, and these are the exciters, the condenser-water pumps and the brine pump for the dehumidifier.

Where low-pressure systems are installed, it is not so important to keep the aërating system going as in the high-pressure system. It does not affect the ice so much as in a high-pressure air system. It is well, however, to have the air blowers equipped with automatic starters as already outlined. In the low-pressure system it is also well to arrange the agitators, exciters and condenser-water pumps for automatic operation.

All auxiliary motors should be provided with an approved form of safety switch or preferably a circuit breaker in a box. The use of a circuit breaker well warrants the additional expenditure, as it eliminates fuses and the danger of motors operating single-phase and burning out. Besides, it provides more continuous operation. In case of a temporary overload or short-circuit it is merely necessary to reclose the handle to start again. With a fused switch it is necessary to replace the fuse, and this often takes quite an appreciable time.

Where remote control is desired, it is necessary to use a magnetic switch. There are some types on the market that are unsuitable because they are not sufficiently waterproof, and besides they use a thermal element to heat a metal strip which directly operates in the holding coil circuit to clear the motor from the line. This type of starter works satisfactorily only after the starter has been in operation for a long enough time to heat the metal strip to operating temperature. If the starter is operated when cold and the motor stalls, it will fail to function satisfactorily.

While it is departing somewhat from the title allotted, yet an excellent investment for an ice-making and refrigerating plant employing a number of motors, is to purchase an air gun, thoroughly clean the motors and spray them with a good insulating waterproof varnish.

Bearings should be examined and air gaps checked up. Thermometer readings should be taken occasionally to determine whether the motors are operating at a higher temperature than is safe.

An occasional examination of rotor end rings should be made, particularly where soldered rotors are used. This is a source of trouble in induction motors, although the almost universal use of rotors with a cast end ring has considerably reduced the trouble from this source.

Clearance Requirements in Synchronous-Motor Installation

In the installation of synchronous motors, particularly the engine type for driving air and ammonia compressors, a clearance between rotor and stator should be less at the top than at the bottom. A good rule is to have ⅛ less air gap at the top of the rotor than at the bottom. This takes part of the load off the bearings and allows for greater wear. Great care should be taken to check up and find that the air gap is never less at the bottom than at the top, for this would add a greater load on the bearings due to magnetic pull. Practically all machines now have adjustable bearings, so that any bearing wear can be taken up and the rotor centered. A periodic inspection of the air gap should not be neglected and adjustments made if necessary.

In operating synchronous motors where power-factor meters are installed, always operate as near unity power factor as possible and wherever possible operate at a leading power factor. It is always preferable to do so as it helps correct power factor on induction motors driving auxiliaries, and will lessen the kva. load on the transformer bank.

Pay particular attention to the contacts on the field switches. See that these are not burned. It is essential to have the field switch make a proper connection through the field discharge resistance when the field is open. A

*Abstract from a paper, "Control of Electrical Equipment in Ice Making and Refrigerating Plants," presented at the Memphis Convention of the National Association of Practical Refrigerating Engineers, Dec. 12 to 16, 1923.

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poor connection may result in damage to the motor when starting up.

Every ice-making and refrigerating plant should be provided with a graphic or curve-drawing wattmeter. This is a direct indication of the kilowatt demand, and this together with a venturi ammonia meter is as important for the economic operation of a plant as properly calibrated gages on the suction and discharge lines.

Crane and Hoisting Motors

Owing to the moisture, rough usage and the liability to shocks, all crane and hoisting motors in ice plants should be operated through a special set of step-down transformers, preferably at 110 volts. The small loss due to the lower voltage is negligible as compared to the benefits, and it is well worth while operating the crane and hoisting motors from separate low-voltage transformers. The delta-delta scheme of connections for the transformers should be used, arranging them so they can be operated open-delta in the event of losing a transformer.

High-and-Low Alarm Necessary

High-and-low alarm pressure gages should be installed on the high-pressure ammonia line as well as the water line furnishing water to the condensers.

Suction and discharge gage recording instruments are a valuable adjunct to any plant. There are several types that have been developed and proved satisfactory. Electric temperature recorders are an excellent check and are now developed so a recorder can be located in the chief engineer's office and lines can be run from the ice-storage room, brine tanks, forecooler, condenser-water inlet and discharge. In cold storage the various rooms can be arranged for direct readings so that the chief engineer can switch to any circuit and read the temperature. These recorders are made with one or more recording pens with different inks, so that on one chart various temperatures can be recorded.

Emergency Stops Should Be Provided

On each compressor driven by a synchronous motor an emergency stop should be provided by mounting a normally open push-button switch and connecting it so as to short-circuit the low-voltage release coil. Of course the low-voltage release coil should be arranged in series with a resistance for operation in this manner and is much to be preferred to the normally closed button which only introduces another point of contact in the low-voltage release circuit and is liable to lead to trouble.

For further protection in the event of an accident a circuit could be run to various points in the plant mounting normally open push buttons in glass-front fire-alarm type boxes, and this circuit could be arranged to open the main oil switch so that the entire plant can be shut down from several points if desired.

In electrically operated plants where the lighting is taken from the main source of supply, it is well to run an auxiliary lighting circuit, furnished either from storage batteries or from a separate feeder and install an automatic switch. There are several on the market arranged with a solenoid so that when the main source of supply is connected, the solenoid is energized and the switch is kept closed, completing the circuit. In the event of interruption the solenoid is de-energized and the switch drops, closing the circuit on either the storage battery or auxiliary source of supply providing temporary lighting. On the resumption of the main source of supply the solenoid is energized and lifts the switch to the main source of supply. These switches are almost instantaneous so there is practically no interruption in lighting should the main source of supply fail.

Burning Pulverized Coal

In a series of tests on pulverized coal at a Milwaukee power plant, the Bureau of Mines makes the following conclusions:

The rating that can be developed efficiently by a boiler depends almost entirely on the size and shape of the combustion space; this space is more effective if so arranged as to give the flames the longest possible travel through the furnace. With this type of furnace and burners the most efficient rate of combustion is 1 to 1½ lb. of coal per hour per cubic foot of combustion space. Good results can be obtained between the rates of 0.6 and 2 lb. of coal per cubic foot per hour.

Combustion seems to be completed more rapidly if the flames impinge on hot refractory material, but such impingement causes excessive slagging and erosion of the refractory.

Spreading burners seem to have caused less slagging, and to have given better results at higher rates of combustion than round burners. Slagging depends on the fusion point of the ash in the coal and on the furnace temperature; the latter rises with the percentage of carbon dioxide in the furnace gases. The ash in Illinois coal becomes soft and sticky at about 2,000 deg. F., and slag begins to form when the CO_2 in the flue gases exceeds 10 per cent and the rate of combustion exceeds 1.3 lb. of coal per cubic foot of combustion space per hour. Attempts to keep the bottom of the furnace cool and free from slag by introducing air through the slag doors caused the flames to rise and to shorten their path through the furnace, with the result that unburned carbon passed out of the furnace. It seems that the best way to avoid excessive slagging without increasing the excess air is to cool the bottom of the furnace by placing a waterscreen above it. Erosion of the brick lining can be greatly reduced by keeping the flames from striking against it.

The efficiency of combustion is not affected to any appreciable degree by increasing the coarseness of coal, so that only about 65 per cent passes through a 200-mesh screen.

The pulverized-coal plant was operated for over three weeks with undried pulverized Illinois coal. It was found that undried Illinois coal containing as much as 7 per cent moisture can be fed steadily by the feeders and burned efficiently in the furnace; it can also be moved by screw conveyors. When its moisture content exceeds 7 per cent, the coal begins to pack in the conveyors and feeder bins, although it seems to burn well when it reaches the furnace. The only disadvantage in burning undried coal is more difficult ignition when a fire is started with a cold furnace.

Diesel Engines for Largest Motor Liner

The Union Castle Mail Steamship Co. has ordered a large twin-screw motor passenger liner of over 20,000 tons gross for its South African service. The new vessel will be built by Harland & Wolff, Ltd., at Belfast and will be equipped with two sets of double-acting, eight-cylinder Diesel engines, developing approximately 20,000 indicated horsepower.

This will be by far the largest motor ship in the world and also the most powerful yet designed. The striking advance in marine Diesel-engine practice has been rendered possible by the double-acting construction without the necessity of increasing the diameter of the cylinders more than a few inches above the diameters in common use among the numerous single-acting Diesel engines that have been in service for several years.

The pumps for circulating salt water, fresh water and lubricating oil in the main engine room and, in fact, all the auxiliaries in the machinery spaces as well as for deck purposes, will be electrically driven. Electrical power will be available also for fans, heating and cooking, etc. The generator sets, provided with their attendant auxiliary gear and switchboards, constitute a generating station comparing favorably as to size with that of many a fair-sized town.

New York is still the leading state in the amount of developed water power, with approximately 1,300,000 hp.; California is a close second, with something over 1,100,000 hp.; Washington is third, with 454,000 hp.; Maine closely follows in fourth place, with not quite 450,000 hp.; Montana is fifth, with 344,000 hp.

Although the Colorado Fuel and Iron Company's large steel mills were shut down part of the time during 1923, and this concern not only mines but uses a huge amount of coal, the state's production of coal during 1923 was 10,405,875 tons, as compared with 9,974,939 tons during 1922.

Hoover Outlines Future Needs of Engineering Education

Engineer Must Sense His Public Obligations as Well as His Professional Knowledge

SECRETARY of Commerce Herbert Hoover, first president of the American Engineering Council, outlined a general plan of education for the Council, addressed to the Engineers of the country, in a communication to James Hartness, the present president of the Council, as follows:

We are facing a time, in the development of our civilization when we must find some sort of a bridge between the extreme individualism of the last century and the possible inroads of those forces that would extinguish that individualism entirely.

There is somewhere to be found a plan of individualism and associational activities that will preserve the initiative, the inventiveness, the individual, the character of man and yet will enable us socially and economically to synchronize this gigantic machine that we have built out of applied sciences. Now, there is no one who could make a better contribution to this than the engineer, but to make that contribution our engineers in the future must have a broader and stronger place in our world affairs than they have today.

We cannot be turning men out of our universities, as we are in many cases today, purely mechanical machines devoted to some theory built on applied sciences. If the engineer is going to take his part in this community, if he is going to give expression to those things that he can express best, he must start with a sense of his public obligation as well as his professional knowledge.

The engineer really has a contribution to make, with his precision of thought, his capacity to analyze conclusions and to obtain the proper perspective of fact and his ability to weigh the forces with which he deals. He has a place beside our commerce, a place beside our social problems, that is not yet filled.

One of the difficulties of my own position is that I am presented with economic arguments pro and con in matters in which I must find interpretation from forty arguments on one side and ten on the other, and the average economist wishes to balance the thing three-fourths. It is the engineer who can take these arguments and weighing them in their human units, can draw a balance sheet upon which the policies and ideals of the country can be formulated.

But we are not going to attain this position for the engineer—this right and this obligation on his part to take his position in national councils, to exert his opinions alongside of even the organized farmer, the organized laborer, the organized chambers of commerce—unless the engineer himself has been broadened out of the narrow groove that most of us were deliberately trained in when we were boys.

I realize that the area that we must cover in education has now become so broad as to be almost exhaustive. I realize that my grandfather went to school for five years, that my father went ten years, that I went fifteen years, and that my son is now engaged in studies that will cover fully twenty years, but we had better reduce the volume of science and applied science we are pouring into our young men in order to make room for some stimulation of their public relationships, some realization of their public obligations.

I am not dwelling on this even as a matter of cultivation—cultivation of mind or cultivation of character. I myself do not believe there is any greater cultivation than that of an engineer's training in itself. But what the engineer needs is the thing that the American Engineering Council was founded to bring about, and that was the employment of the engineer's mind and method of thought in this country.

We are not going to have that full value until we have brought by a new generation of engineers of wider individual attainments than the present, a keener realization and appreciation of these matters.

And it is precisely for this reason that I am anxious to see the American Engineering Council continue and grow strong, because unless we have some central point that at least keeps the lamp of public service and relationship alight in the engineering profession, we shall go back into the dark ages, where we were twelve years ago, in our perhaps hermit-like attitude toward public service and questions.

We are all of us interested from an Engineering Council point of view in the relationships of the engineer and in the relationships of our own engineers and their subsequent relationships to public service. Engineering Council is an attempt to express the views of the American engineer on perhaps questions considerably afield from engineering.

It was constructed in the hope that the engineer might take his place among the associational activities of the country, in an expression of the engineer's mind on public questions; that he might take opportunity with other great associational activities in molding policies perhaps not altogether of legislative complexion, but policies rather of a social and economic complex.

It was thought by those of us who entered into the formation of the organizing Conference that the engineer had something to contribute; that his training was a training of great precision, of great definiteness of thought, of careful and weighted preparation before expression; that his association in his professional life brought him into contact with the human as well as the purely economic and industrial questions with which he dealt.

War Department to Clean Up Surplus Property

The War Department announces that it will make every effort to clean up the remaining war surplus property before the close of the fiscal year, June 30, 1924. Sales will be held in army depots in Brooklyn, Chicago, San Francisco and San Antonio. These sales will be quartermaster auctions and consist principally of textiles, wearing apparel and general merchandise. Sales will also be held of real estate and manufacturing plant holdings in the United States and Canada.

Another Attempt to Solve Colorado River Problems

The bill known as the Swing-Johnson bill now pending in Congress takes up the construction of a dam 600 ft. high in the Boulder Canyon which is located on the Colorado River, where the river forms the boundary between the states of Nevada and Arizona. The plan calls for the storage of the entire runoff and flood waters of the Colorado River, for irrigating purposes, the generating of immense amounts of hydroelectric power and an all-American canal through the Imperial Valley. The bill advocates construction along the lines endorsed by the Reclamation Service and the sale of power privileges in accordance with the policy of the Federal Power Commission which would allow of the development of 1,000,000 hp., the irrigation of 3,000,000 acres of arid land, and the prevention of floods which so disastrously devastated the Yuma and Imperial valleys and created the Salton Sea during the years of 1905 and 1906. A provision of the bill would permit of the veterans of the World War, Philippine Insurrection and the Spanish American War being given preferential rights for entry for homesteading.

How this bill will be received in view of the present controversy between the states through which the Colorado River flows is not known.

Offers for Muscle Shoals Continue to Arouse Discussion

Ford Offer Amended—Union Carbide Co. Offer Is In—Utilities Company Fertilizer Offer to Be Submitted Soon

DISCUSSION of the various offers for the government's Muscle Shoals properties before the Military Affairs Committee of the House of Representatives has had the effect of bringing these offers to a comparable basis. The Committee, or a special committee, if one should be appointed, now has before it information that will permit it to negotiate. The sentiment on the Committee in favor of the Ford offer, however, is so strong that there is determined opposition to the appointment of a joint negotiating committee, and it is not unlikely that the committee will report favorably upon the Ford offer without taking advantage of the unusual opportunity it has to make a better deal with the interests who have submitted offers.

The Union Carbide Co., submitted its offer signed by E. F. Price, the president of the company on Jan. 26.

The offer is a proposal to lease Nitrate Plant No. 2, Waco Quarry and 50,000 hp. of power. The company agrees to take up an additional 50,000 hp. under certain conditions. It agrees to pay $150,000 a year for the use of the plant and the quarry.

The Carbide company plans to operate the plant to produce urea and phosphazote at cost plus 5 per cent. It agrees to conduct research and promises to maintain a production capacity of 40,000 tons of nitrogen for the full fifty years.

Among the points made at last week's hearing was a calculation showing that electricity produced at Muscle Shoals during 1926 would cost Mr. Ford one mill per kilowatt-hour of primary power. In 1936 it would reach its maximum cost at 1.9 mills per kilowatt-hour. This is one-sixth of the amount a similar volume of power would cost any other user. Based on the primary power alone at Muscle Shoals, this would make a difference of $15,000,000 per year. That is the amount, it was argued, that the government would be subsidizing Mr. Ford's industry. If he should choose to use the power for the operation of cotton mills, it was pointed out, all would understand that the owners of all other cotton mills of the country would be at a great disadvantage because of Mr. Ford's governmental subsidy.

On Tuesday Mr. Kahn presented to the Committee the following telegram which he had received from Henry Ford:

Our offer for Muscle Shoals still stands. The MacKenzie bill, with the Madden enactment, as printed in the Madden bill, is satisfactory with following suggested amendments of section 19, page 17, beginning at line 5 of the Madden bill: "A suitable site for a steam power plant, to be located at or near lock and dam numbered 17, Black Warrior River, Alabama, or upon a site to be mutually agreed upon by the government and Mr. Henry Ford, together with a strip of land 100 ft. wide to serve as a right-of-way for transmission and transportation purposes between dam numbered 17, Black Warrior River, or a site to be agreed upon between the government and Mr. Henry Ford, and nitrate plant No. 2, Muscle Shoals, Alabama, with connection to Waco quarry near Russelville, Alabama," remainder of section as appears in bill.

A representative of the Southern Public Utilities Co. estimated the cost of the right-of-way from lock 17 at $100,000, if the intention is to build a railway line. If it is simply for a transmission line, the cost would be $46,000.

One of the most telling points brought out against the Ford offer was the fact that while the public-utilities companies would be rigorously regulated, no such safeguard would exist were the Ford offer accepted.

At this writing, the public-utilities companies expect to submit their fertilizer offer on Jan. 25.

Cornell Establishes An Experiment Station

Cornell University has recently established an Engineering Experiment Station in connection with the College of Engineering. The effect of this action is to centralize all the engineering research activities of the college, as all the facilities of the laboratories will be at the disposal of the station. The executive staff consists of Dean D. S. Kimball as director, assisted by F. A. Barnes, of the School of C. E., H. Diedrichs, of the Sibley School of M. E., and P. M. Lincoln, of the School of E. E. There is also an advisory committee made up of Professors Ogden, Schroeder, Scofield, Conwell, Burrows, Boothroyd, Albert, Barnard, Wood, Sawdon, Upton, Karapetoff and Ballard.

Italian Engineering Students To Be Aided by Council

James Hartness, president of the American Engineering Council, announces that the Council will aid the Italian Ambassador, Prince Gelasio Caetani, in furthering "intellectual immigration" from Italy.

Fifty young Italian engineers, recent graduates of technical schools, will sail soon for New York, and from there be sent to industrial centers to become simple laborers in large manufacturing plants. This band of fifty will be followed this year by at least a hundred more, annual migrations being planned. The American Engineering Council, in response to a communication from the Ambassador has voted to co-operate with the Italian Embassy and the United States authorities in securing places for the young Italians and in looking after their general welfare. Twenty-five of these students will go to the Ford plant, seven to the Westinghouse Manufacturing Co., and three to the General Electric Co. The others will be distributed in large plants in the Eastern and Middle States.

Museum of Engineering and Industry Considered

The Joint Conference Committee of the Four Founder Societies are considering the project of a National Museum of Engineering and Industry as proposed by the Organization Committee of twenty-five. Further study and consideration of the project will be made and a report given at the next meeting of the Committee, which will be on Mar. 11.

Rockwood to Endow A.S.M.E. Gold Medal

George I. Rockwood, vice-president of the American Society of Mechanical Engineers, will endow a gold medal of the Society to be awarded "in those rare cases when an individual has succeeded by the exercise of his genius and character in powerfully assisting the fortunes of our country or the general engineering progress of the world."

The proposal to endow such a medal was received from Mr. Rockwood by the Council at its meeting in Washington Jan. 8. After a vote of appreciation of his generosity and purpose, Council referred the matter to the Committee of Awards and Prizes. It is Mr. Rockwood's desire to have the name of the medal impersonal.

Mr. Rockwood is a life member of the Society, an ex-member of the Committee on Publication and Papers, and a past-manager. Since 1906 he has been president and treasurer of the Rockwood Sprinkler Co., of Worcester, Mass.

World Power Conference Plans Include Special Steamer

Plans for engineering societies meetings to be held in London in connection with the World Power Conference in July include arrangements to charter one of the Cunard Line steamships, which will sail in time to reach England for the beginning of the Conference, June 30. A notable gathering of engineers is already assured, and America is to be well represented.

President Fred R. Low has accepted in the name of the Council of The American Society of Mechanical Engineers an invitation of the Council of the Institution of Mechanical Engineers to attend their meeting in London next summer.

The date of this meeting will be set so as to permit attendance at the World Power Conference to be held in London June 30 to July 12, 1924. Many American engineers are planning not only to attend, but to take a prominent part in this Conference, which will consider how the industrial

and scientific sources of power may be adjusted nationally and internationally.

There will be invaluable opportunity to compare experiences in the development of scientific processes with technical experts from all the leading countries of Europe. Educational methods in the different countries will be reviewed, and there will be thorough discussion of the financial and economic aspects of industry, nationally and internationally.

Pigeon River Project To Go Through

Early action on the Pigeon River project of the Pigeon River Power Co. is expected. The project is situated between Asheville and Knoxville, in the region where large water-power development is expected in the comparatively near future. It is understood that the American Power & Light Co. has secured a controlling interest in the Pigeon River Power Co. and that plans are being worked out for the early development of 60,000 hp. of very cheap power.

The development of this site has been agitated for several years. Difficulties with riparian owners and uncertainty as to market have delayed action heretofore.

Priest Rapids To Be Huge Development

Construction will begin on one of the largest hydro-electric power plants west of Niagara, when plans for the development of Priest Rapids are terminated. Priest Rapids is situated in the middle of the State of Washington, equidistant from Spokane and Seattle on the Columbia River. The project includes the building of a dam three miles long and 190 ft. high, which will create a lake ten miles long and four miles wide. As announced in the Nov. 13, 1923 issue of *Power*, the project as outlined will develop 350,000 hp., but it is expected that during high water 300,000 hp. additional will be developed.

The project, which is being put through by the Washington Irrigation & Development Co., of which Henry J. Pierce of New York is president, includes, besides the hydro-electric plant, the building of a large modern city and the irrigation of a desert. It is estimated that the cost will be in the neighborhood of $250,000,000, of which $28,000,000 will be spent on the dam. As planned, Priest Rapids will become the Western center of the electrochemical industries at present located at Niagara Falls. The new plants and factories will supply General Electric products not only to the West but to Asia as well.

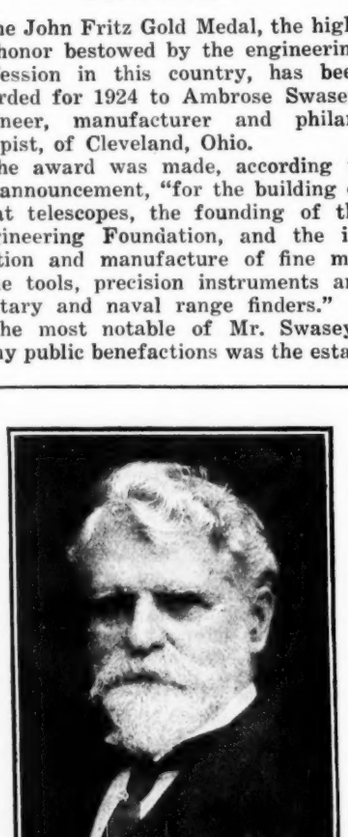
The irrigation project is of secondary importance, but it will reclaim 70,000 acres of desert sagebrush now owned by the company. A memorandum from the Department of the Interior says that the final report on the proposed Columbia River Basin irrigation project will be submitted to Congress about the middle of March.

Swasey Awarded John Fritz Gold Medal

The John Fritz Gold Medal, the highest honor bestowed by the engineering profession in this country, has been awarded for 1924 to Ambrose Swasey, engineer, manufacturer and philanthropist, of Cleveland, Ohio.

The award was made, according to the announcement, "for the building of great telescopes, the founding of the Engineering Foundation, and the invention and manufacture of fine machine tools, precision instruments and military and naval range finders."

The most notable of Mr. Swasey's many public benefactions was the establishment, through a gift of $500,000, of the Engineering Foundation as the joint research instrumentality of the four great national societies of civil, mining and metallurgical, mechanical and electrical engineers.



Ambrose Swasey

Mr. Swasey is a past president and honorary member of the American Society of Mechanical Engineers, an honorary member of the American Society of Civil Engineers and of several other engineering societies of America and Europe. He is an Officer of the Legion of Honor of France and has received other honors at home and abroad.

Among the famous telescopes built under the direction of Mr. Swasey are the 36-in. Lick refractor at Mt. Hamilton, Calif., the 26-in. telescope of the Naval Observatory at Washington, the 40-in. telescope of the Yerkes Observatory at Williams Bay, Wis., and the 72-in. reflecting telescope of the Dominion Astronomical Observatory at Victoria, B. C.

The medal was established in 1902 in honor of John Fritz, of Pittsburgh, pioneer in the American iron and steel industry, and is awarded annually for notable scientific or industrial achievement. Previous recipients have been Alexander Graham Bell, Gen. George W. Goethals, Guglielmo Marconi, Sir Robert Hadfield of London, and Eugene Schneider of Paris, head of the Creusot works.

Engineering Council Chooses Officials

L. P. Alford of New York, and Col. Charles R. Gow, of Boston, have been elected vice-presidents of the American Engineering Council, it has been announced recently by James Hartness, the president of the Council. The Council now has four vice-presidents, the others being Calvert Townsend, of New York, and Gardner S. Williams, of Ann Arbor, Mich. E. E. Howe, of Washington, continues as treasurer and L. W. Wallace, of Washington, as executive secretary.

Representatives of national organizations for the coming year have been chosen as follows:

A. S. M. E.: Dean M. E. Cooley, University of Michigan; Dean A. M. Greene, Jr., Princeton; F. K. Copeland, Chicago; L. P. Alford, Fred R. Low and Major Fred J. Miller, New York. A. I. E. E.: Col. J. H. Finney, Washington; Prof. Dugald C. Jackson, Massachusetts Institute of Technology; C. E. Skinner, Pittsburgh; F. B. Jewett and L. F. Morehouse, New York. M. G. Lloyd, chief of the Safety Section of the U. S. Bureau of Standards, will represent the American Society of Safety Engineers; S. H. McCrory, United States Bureau of Public Roads, the American Society of Agricultural Engineers, and H. E. Howe, Washington, the American Institute of Chemical Engineers.

New York Refrigerating Engineers Meet

The Metropolitan section of the American Society of Refrigerating Engineers held its first 1924 meeting at the Machinery Club, New York City, on Jan. 17. Preceded by a dinner, the session was devoted to a talk by Gardner Vorhees on the several devices he has developed with a view to decrease the cost of ice making.

Refrigerating engineers are known to be conservative, and it was not surprising that a number who engaged in the discussion doubted that multiple-effect compression, two-effect cooling or the Vorhees double-freezing systems would show substantial gain, even though the speaker had cited records of actual plant operation to substantiate his claim.

The double-freezing system embraces the plan of first freezing a narrow cake which afterward is to be placed in a standard can and the spaces between the can sides and the small cake filled with water. Since the time of freezing varies with the square of the thickness of the cake, the double system should reduce the freezing time from, say, 48 hours to 12 hours. The objection raised to the plan was that ice pullers would object to the extra pulling required. In the discussion the statement was made that the usual pay of ice pullers in

New York City was $55 per week, a decided contrast to the average engineer's wage of $42.50, especially since ice pulling is unskilled labor. Some felt that the ice peddlers had the ice plant under their control and would refuse to buy the double-frozen ice by reason of the existence of two feathers in place of the center feather, or white streak, which exists in all raw-water ice. Since the refrigerating effect of the double-frozen ice is equal to that of the standard cake, the business acumen of the ice manufacturers in allowing the peddlers to so control the business that increased efficiency cannot be obtained in the plant, is open to serious comment.

M.E.B.A. Hold Successful Convention

The Marine Engineer's Beneficial Association held its 49th annual convention at the Franklin Square Hotel, in Washington, D. C., Jan. 21-26. Optimism replaced the depression which was apparent at last year's meeting, caused by the condition of deflation in the merchant marine. A good attendance of delegates, full of confidence and interest, promises an early and complete restoration of the harmony and prestige which the association for years has enjoyed.

The usual annual smoker was replaced by a banquet in the Gold Room of the Franklin Square Hotel, at which about 125 delegates and guests were present, President William Brown in the chair. Addresses were made by Gen. George A. Uhler, Supervisor General, United States Steamboat Inspection Service, and for years national president of the association; T. V. O'Connor, vice-chairman of the United States Shipping Board, who sounded a note of hopefulness and appreciation of the association in his address, dealing with the merchant marine; William Yates, another past-president of the association; Hon. E. J. Henning, Assistant Secretary of Labor; Judge Theodore G. Risley, Solicitor, Department of Labor; J. C. Jenkins, Director of Industrial Relations, United States Shipping Board. The addresses were interspersed with songs and stories by some of the New York delegates and by local talent.

On Wednesday evening, Mr. and Mrs. A. Warren France entertained the delegates and guests of the convention. The ladies were entertained during the convention with auto rides, visits to Mt. Vernon and Alexandria and a theater party. The members of the convention were received at the White House, by President Coolidge, on Thursday.

There was no election of officers of the Marine Engineers' Beneficial Association itself, but the Supplymen's Association of the Marine Engineers' Beneficial Association elected the following officers: President, S. D. Blunt, Tidewater Oil Co.; vice-president, Frank H. Shipman, Texas Oil Co.; secretary and treasurer, F. J. Thrush, The Leslie Company.

Pasadena Building New Steam Plant

The Municipal Light and Power Department of Pasadena, Calif., is constructing a new steam power plant west of its old buildings. The first unit is alternating-current 12,500 kva., steam being furnished by two water-tube boilers of 10,000 sq.ft. of heating surface each and two of 8,500 sq.ft. of heating surface each, to be operated at 250 lb. steam pressure at 150 deg. superheat. This equipment is being housed in a new concrete building which will be fireproof throughout, with steel truss roof, 50-ton overhead crane, condensing equipment, cooling tower and all necessary power-plant piping. Complete electrical switchboard equipment is being installed, with switches of ample breaking capacity as required in modern interconnected stations.

The city has been purchasing some of its power, but the price remains so high that it is necessary to expand the steam plant in order to benefit by the exceedingly low price of fuel oil that prevails at the present time, and which will enable the city with its new plant to save considerable in the cost of generation over that of the old plant and also over what it can purchase hydro-electric power for. It will also give the city an independent position by maintaining a steam plant that can be used in years of shortage of power and in emergencies. Even with an increase in the price of fuel oil a modern plant will enable the municipality to generate electricity at a much lower cost than it could be generated for with the old plant, which has become inadequate on account of the tremendous growth of Pasadena and the increased demand for electrical energy.

New York Legislators Agree on Power Control

GOVERNOR SMITH of New York and Republican leaders of the Legislature, in a conference on January 24, came to an agreement in principle upon a policy of state-controlled water-power resources and the creation of a commission to make a survey of the power available for development. A commission is to be created to report to the Legislature in 1925, but in the meantime the water-power law enacted during Governor Miller's term of office is to continue in force.

The agreement on water power amounts to little more than a declaration of policy by the state and clears the way for setting up the machinery for eventually carrying out the policy. It is not made binding in law and may not be sanctioned by the succeeding Legislature if there should be a change in administration next year.

Washington State Considering Two Power Bills

Two power bills affecting municipal stations in the State of Washington are expected to be framed and presented to voters at the next annual election. The first of these, known as the Bone power bill, provides that city-owned power plants may extend their operations beyond the municipal corporate limits, giving wide expansion in marketing powers of such stations. The other measures, known as the Erickson bill, permits the formation of power districts by townships, counties and other large territorial units, with the construction of individual generating plants, if desired, and extending, in full, the same privilege of community ownership to these power districts, so formed, as now enjoyed solely by municipalities in the state.

Bill to Protect Public in Patent Office Business

A bill to prevent fraud and improper practice in business before the United States Patent Office was introduced in the House Jan. 19, by Representative L. C. Crampton, of Michigan. It would provide penalties for persons professing to be patent attorneys or organizations professing to render assistance at the Patent Office if not registered and permitted to practice in that governmental agency. Representative Crampton, in explanation of his bill, said:

In Washington and a number of other places throughout the country, individuals, firms and even corporations are acting as patent attorneys and inducing clients to intrust important patent business to them with the idea that they are registered to practice. The bill is designed to prevent anyone from practicing before the Patent Office who is not registered to practice or who has been disbarred after having been registered, thus giving the Patent Office an opportunity to protect the public by preventing practice before it by unscrupulous persons.

Water-Power Projects

Chattahoochee River Project—Stone & Webster, acting for the Columbus Electric Co., of Columbus, Ga., has filed a declaration of intention with the Federal Power Commission covering a 120-ft. dam in the Chattahoochee River at a point 18 miles above Columbus. It is proposed to develop 40,000 hp. at that point, but the plans include an ultimate development of 80,000 hp. The proposed dam will create gross storage to the extent of 200,000 acre-ft. It is planned to use the upper 100,000 acre-ft. as live storage. The declaration has been referred to the Chief of Engineers to ascertain the probable effect of this development on navigation in the lower stretches of the river. Columbus is the present head of navigation. There are several smaller dams between Columbus and the proposed de-

velopment, but since this project contemplates such a large amount of storage, it is believed probable that the federal government will take jurisdiction.

Licking River Project—The Federal Power Commission has received an application for a preliminary permit from the Kentucky Northern Power Co., of Frankfort. The project is backed by Indianapolis capital led by H. A. Mansfield, of the Mansfield Engineering Corp. The site covered by the application is on the Licking River, three miles above Falmouth, Ky. It is proposed to erect a dam 94 ft. high, which is expected to develop 35,000 hp. The principal market for the power will be in Cincinnati and vicinity.

The indications are that the proposed development is a feasible one, and it is fully expected that it will go through in due course.

Blanchard Rapids Project—The Minnesota Power & Light Co. has purchased the plant of the Little Falls Water Power Co., Little Falls, Minn., including power rights on the Mississippi River at Blanchard's Rapids, near Little Falls. The company plans to develop the Blanchard's Rapids site immediately by the construction of a hydro-electric power plant with an initial installation of 18,000 hp. and an ultimate installation of 27,000 hp. The new plant will be connected with the present hydro-electric plant of the Water Power Company in Little Falls and to the Minnesota Power & Light Co.'s present system at Nashwauk, Minn., by a high-tension transmission line.

Skokomish River Project—The City of Tacoma has applied to the Federal Power Commission for a license to cover a minor portion of its Skokomish River project. In carrying through this large development, nine acres of the Olympia National Forest will be flooded. The remainder of the project does not come within the purvue of the Federal Power Commission.

The city's plan is for two large developments on the North Fork of the Skokomish River. It proposes to put in a dam four miles below Lake Cushman. The reservoir then would extend to a point three miles above that Lake. Approximately 3,500 kw. would be developed at that dam. A second dam is to go in two miles below the first one. From that dam a diversion tunnel is to be built to a power house, two miles away, on the bank of the Hood Canal. At that point 70,000 kw. will be developed. The project involves the construction of a transmission line forty miles long to carry the output of these plants to Tacoma.

Society Affairs

The Columbus, Ohio, Section of the A.I.E.E. will hold a joint session with the Illuminating Engineers on Feb. 15. The subject of the meeting is to be "Superpower."

The Buffalo Section of the A.S.M.E. will hold a joint meeting at Hotel Statler with the S.A.E. on Feb. 4. Lawrence Pomeroy will speak on "Oil and Engine Efficiency."

The Detroit Engineering Society will be entertained at its meeting on Feb. 15 by Frederick A. Scheffler, Fuller Engineering Co., New York City. His subject will be "Pulverized Coal," and he will discuss the subject as applied to boiler and metallurgical installations.

The Metropolitan Section of the A.S.M.E. will hold a joint dinner meeting on Feb. 3 with the A.S.C.E., A.I.M.E., A.I.E.E. and S.A.E. in cooperation with the War Department. The subject will be "Industrial Preparedness as Insurance Against War." Judge Elbert H. Gary will preside, and Dwight F. Davis, Assistant Secretary of War, and Col. James A. Walsh will speak.

Coming Conventions

American Ceramic Society. Ross C. Purdy, Lord Hall, Ohio State University, Columbus, Ohio. Convention at Atlantic City, Feb. 4-8.

American Electrochemical Society. C. G. Fink, Columbia University, New York City. Meeting at Hotel-Bellevue-Stratford, Philadelphia, Pa., April 24-26.

American Institute of Electrical Engineers. F. L. Hutchinson, 29 West 39th St., New York City. Midwinter convention at the Bellevue-Stratford Hotel, Philadelphia, Feb. 4-8. Spring convention at Birmingham, Ala., April 7-10.

American Institute of Mining and Metallurgical Engineers. F. F. Sharpless, 29 West 39th St., New York City. Annual meeting at New York City, Feb. 18-21.

American Society of Mechanical Engineers, Calvin W. Rice, 29 West 39th St., New York City. Spring meeting at Cleveland, Ohio, May 26-29, formerly announced, May 19-22.

American Water Works Association. J. M. Diven, 153 West 71st St., New York City. Annual convention at New York City, May 19-21.

Indiana Engineering Society. Charles Brossman, 1503 Merchants Bank Bldg., Indianapolis, Ind. Annual meeting at Lincoln Hotel, Indianapolis, Ind. Feb. 14-15.

Iowa Engineering Society. Blanche Veig, Acting Secretary, 406 Flynn Bldg., Des Moines, Iowa. Annual meeting at Cedar Rapids, Jan. 29-Feb. 1, 1924.

Master Boiler Makers Association. H. D. Vought, 26 Cortlandt St., New York City. Meeting at Chicago, May 20-23, 1924.

National District Heating Association, D. L. Gaskill, 112 West Fourth St., Greenville, Ohio. Annual convention at New York City, June 11-14, 1924.

National Electric Light Association. M. H. Aylesworth, 29 West 39th St. New York City. Annual convention at Atlantic City, Young's Million-Dollar Pier, May 19-24.

National Electric Light Association, Technical National Section. H. P. Liversidge, Philadelphia Electric Co., Philadelphia, Pa. Section meeting at Birmingham, Ala., Jan. 28-Feb. 1.

Society of Industrial Engineers. George C. Dent, 608 South Dearborn St., Chicago, Ill. Eleventh annual convention at Buffalo, N. Y., April 30 to May 2, 1924.

World Power Conference. O. C. Merrill, Federal Power Commission, Washington, D. C. British Empire Exhibition, Wembley, London, June 30-July 12.

The Cincinnati Section of the A.I.E.E. will have as the topic of its meeting on Feb. 14, "Elevator Control." Oscar F. Shepard, of the Shepard Elevator Co., will be the speaker.

The Affiliated Technical Societies of Boston will have a dinner on Tuesday, Feb. 12, at the Boston City Club. Prof. G. W. Dyer, of Vanderbilt University, Nashville, Tenn., will speak on "Economic Fallacies."

The Toronto Branch of the E.I.C. will have as the subject of its Jan. 31 meeting, "The Great Lakes and a Few of the Structures Thereon." Lt.-Col. H. J. Lamb of the Department of Public Works, will be the speaker.

The St. Louis Section of the A.S.M.E. will have as speaker at its Feb. 1 meeting J. D. Roberts, chief engineer of the Central Illinois Public Service Co. His subject will be "Use of Central-Station Energy in Southern Illinois Coal Fields."

The Providence Engineering Society will hold a banquet at the Hotel Biltmore on Feb. 5. Merle Thorpe, editor of *The Nation's Business*, George Otis Smith, Geological Survey, and Capt. Irving O'Hay, U. S. A., will be the speakers.

The Joint Committee of the Four Founder Societies are considering a policy for the co-operation of local sections of the various engineering societies in a community with one another and with the local engineering organizations. Although there is already in action a policy of cooperation, it is thought advisable to reduce the policy to writing and secure general agreement to it.

Business Notes

The Westinghouse Electric International Co. announces the recent appointment of R. F. Hamilton as manager for the West Coast of South America.

The American Schaeffer & Budenberg Corp., Brooklyn, N. Y., announces that it has recently purchased the important assets, patents, trade marks, trade names, etc. of the Hohmann-Nelson Co., Eau Claire, Wis., manufacturers of Honeco thermometers and temperature controllers.

S. F. Bowser & Co., Fort Wayne, Ind., have made a change in organization. C. H. Davies, formerly manager of the factory division in Chicago, has assumed charge of the factory sales-promotion division of the entire organization, with headquarters in Fort Wayne.

Trade Catalogs

Heater, Air—Combustion Engineering Corp., Broad St., New York City. Bulletin AH-1, 1923. "C.E.C. Air Heaters." shows the construction and operation, performance and installations of this type of air heater for preheating air for combustion.

Conveyor, Ash—Girtanner Engineering Corp., 1400 Broadway, New York City. Leaflet. "How to Save Money in the Boiler Room," gives descriptions of Girtanner standardized steam ash conveyor.

Generators, Waterwheel—Allis-Chalmers Manufacturing Co., Milwaukee, Wis. Bulletin No. 1127 contains 28 pages of illustrations of installations and construction of these waterwheel generators.

Cooler, U-Fin, Air—Griscom-Russell Co., 90 West St., New York City. Bulletin No. 1216 describes this cooler for generator windings by the use of turbine condensate. Drawings, specifications and other material add interest to the catalog of this new air cooler.

Condensers — Nordberg Manufacturing Co., Milwaukee, Wis. Bulletin No. 36 describes Nordberg independent jet condensers equipped with mechanically operated boiler-feed and circulating pumps and driven by a crank and flywheel engine.

Fuel Prices

BITUMINOUS COAL

The following table shows the trend of the spot steam market in various coals (mine run bases, f.o.b. mines):

Coal	Market Quoting	Jan. 14, 1924	Jan. 21, 1924
Pool 1	New York	$3.25	$3.25
Smokeless	Columbus	2.00	2.25
Clearfield	Boston	2.25	2.25
Somerset	Boston	2.50	2.50
Kanawha	Columbus	1.75	1.75
Hocking	Columbus	2.00	2.00
Pittsburgh No. 8	Cleveland	1.90	2.00
Franklin, Ill.	Chicago	2.50	2.50
Central, Ill.	Chicago	2.25	2.25
Ind. 4th Vein	Chicago	2.75	2.75
West Ky.	Louisville	1.75	1.75
S. E. Ky.	Louisville	1.90	2.00
Big Seam	Birmingham	2.15	1.85

FUEL OIL

New York—Jan. 17, light oil, tank-car lots, 28@34 deg. Baumé, 4½c. per gal., 36@40 deg. 5½c. per gal., f.o.b. Bayonne, N. J.

St. Louis—Jan. 16, tank-car lots, f.o.b. St. Louis; 24@26 deg., $1.75@$1.80 per bbl.; 26@28 deg., $1.80@$1.85; 28@30 deg., $1.85@$1.90; 32@36 deg., gas oil, $2@$2.05 per bbl.; 36@40 deg., distillate, $2.15@$2.25 per bbl.

Pittsburgh—Jan. 15, f.o.b. local refinery, 30@34 deg., fuel oil, 5c. per gal.; 36@40 deg., fuel oil, 5½c.; 34 deg., neutral 8½c. per gal.

Dallas—Jan. 18, f.o.b. local refinery, 26@30 deg., $1.30 per bbl.

Cincinnati—Jan. 22, tank-car lots, f.o.b. local refinery, 26@30 deg Baumé, 4¾c. per gal.; 30@32 deg., 5½c.; 38@42 deg., distillate, 6c. per gal.

Philadelphia—Jan. 18, 28@30 deg., $1.78½@$1.82½ per bbl.; 18@22 deg., $1.62½@$1.66½; 13@16 deg., $1.47@$1.51½ per bbl.

Boston—Jan. 22, tank-car lots, f.o.b. heavy oil, 12@14 deg. Baumé, 4⅝c. per gal.. light oil, 28@32 deg. Baumé, 6⅝c. per gal.

Chicago—Jan. 19, 24@26 deg., $2.12 per bbl.; gas oil, 32@36 deg., 4.93c. per gal.

New Plant Construction

Ala., Florence—The United States Engineer Office will take bids until Mar. 1, for four hydraulic turbines, each 35,000 hp. capacity, with governors, as per specifications on file.

Ala., Tuscaloosa—The Tuscaloosa Ice & Cold Storage Co., has acquired a local plant and plans for extensions and improvements, including the installation of additional equipment.

Ark., Fort Smith—The Monol Window Glass Co., is considering the construction of a power house in connection with the rebuilding of the portion of its local plant, recently destroyed by fire with loss of about $200,000.

Calif., Dos Rios—The Carbon Coal Co., Henshaw Building, Oakland, Calif., plans for the construction of a steam-operated power plant at its local properties. A. L. Fisher is general manager.

Calif., Los Angeles—The White-Smith Mfg. Co., will build a steam power house at its proposed furniture manufacturing plant in the central manufacturing district, to cost about $90,000, for which plans are being prepared by Frank D. Chase, Inc., Title Insurance Building, architect and engineer.

Calif., San Francisco—The Pacific Gas & Electric Co., is arranging an expansion program for hydro-electric generating plants and system for the next 36 months, with gross expenditure approximating $50,000,000.

Calif., Seal Beach—The Los Angeles Gas & Electric Corporation, South Hill Street, Los Angeles, has purchased a tract of 8 acres of land at Seal Point, Alamitos Bay Inlet, as a site for a new steam-operated generating plant, with capacity of 290,000 hp., estimated to cost $9,500,000. Plans will be prepared at an early date.

Fla., Anna Maria—The Common Council has tentative plans under advertisement for the installation of a municipal power plant to cost about $40,000.

Fla., Bayboro — The Pinellas County Power Co., operated by the General Engineering & Management Corp., 165 Broadway, New York, has plans in progress for a steam-operated electric generating plant, with initial output of about 6,500 kw. The boilers will be equipped to use oil fuel.

Fla., Dunnellon—E. L. Williams & Son, Pelham, Ga., plan for the construction of a steam power plant at their proposed new lumber plant on local tract of 6,000 acres of land, lately acquired. The entire plant will cost in excess of $85,000.

Fla., Sanford—The Florida McCracken Concrete Pipe Co., a subsidiary of the McCracken Mfg. Co., Sioux City, Iowa, plans for the construction of a power house at its proposed local plant, on site of about 5 acres, recently acquired. W. J. McCracken is president.

Fla., Tampa — The Florida Realty & Mortgage Co., plans for the construction of a power house at its proposed furniture manufacturing plant on tract of land recently acquired, to cost in excess of $200,000. W. F. Miller, president, will be head of the company operating the plant.

Ga., Bainbridge—The Municipal Service Co., Philadelphia, Pa., has acquired the ice-manufacturing and cold storage plants of the Bainbridge Ice Co., and has tentative plans for extensions and improvements. Purchase has been made also of the electric power and ice plants of the Ware County Light & Power Co., Waycross, Ga., and similar expansion and betterment work will be carried out here.

Ga., Blakely — The Blakely Hardwood Lumber Co., is considering the construction of a power house in connection with the proposed rebuilding of its mill, recently destroyed by fire with loss estimated at $100,000.

Ga., Lawrenceville—The Barrow County Cotton Mills, Inc., Winder, Ga., plan for the construction of a steam-operated electric power plant at its proposed local mill, estimated to cost in exceess of $150,000. Park A. Dallis, Candler Building, Atlanta, is architect and engineer.

Ga., Savannah—Law's Leghorn Farm, operated by Louis F. Law, is planning for the construction of an isolated electric power plant at the property.

Ind., Indianapolis—The Thiesing Veneer Co., Harding and McCarty Streets, is reported to be planning for the installation of a power house in connection with the proposed rebuilding of its plant, recently partially destroyed by fire, with loss estimated at $50,000.

Iowa, Greenfield—The Greenfield Light & Power Co., plans for the construction of an addition to its steam power plant, estimated to cost $50,000.

Iowa, Sioux City—The Illinois Central Railroad Co., 135 East Eleventh Place, Chicago, is considering preliminary plans for new repair shops and coaling station at Fourteenth and Floyd Streets, to include a power house. The estimated cost approximates $500,000.

Ky., Fort Thomas—The City Council, R. R. Payne, City Clerk, plans for the installation of an electric-operated pumping plant at its proposed sewerage disposal works and system, estimated to cost $350,000. Norton, Bird & Whitman, Munsey Building, Baltimore, Md., are consulting engineers.

La., Baton Rouge—The Texas Chemical Co., Houston, Tex., plans for the construction of a power house at its proposed sulphuric acid plant, estimated to cost $650,000. A tract of 60 acres of land has been purchased.

La., Gibsland—The Common Council will receive bids until Feb. 5, for equipment for waterworks and power plant extensions, including air lift system, with air compressor, motor, etc.; one generator and switchboard panel; one 50,000 gal. tank, on 75 ft. steel tower, and miscellaneous apparatus. E. T. Archer & Co., Merchants Building, Shreveport, La., are engineers.

La., Monroe—The Chester Carbon Co., 315 Ouachita National Bank Building, will build a large compressor plant for its proposed local carbon black works, to cost in excess of $250,000, with equipment. Percy Learned is president.

Md., Aberdeen—The Puritan Brick Co., G. H. Mitchell, president, Bel Air Avenue, is considering the construction of a power house at its proposed manufacturing plant on local site, estimated to cost $100,000, with equipment. F. A. White, Bel Air Avenue, is company engineer.

Md., Baltimore—The Board of Trustees, Children's Hospital School, Green Spring Avenue and Forty-first Street, will build a steam power house at the new four-story hospital addition, to cost about $200,000. William G. Beecher of Smith, May & Beecher, Galvert Building, is architect.

Md., Baltimore—The Consolidated Gas, Electric Light & Power Co., Lexington Building, will have plans prepared in the near future for a steam-operated generating plant on Gould Street, recently projected to be carried out in the expansion program for the present year. It will cost in excess of $1,000,000.

Mass., Boston — A boiler, engine and pumping plant will be installed in the twelve-story hotel to be erected at St. James Avenue, Stuart and Arlington Streets, by the Statler Hotel Co., Seventh Avenue and Thirty-fourth Street, New York, estimated to cost $4,000,000. Bids will be asked in Feb. by George B. Post & Son, 101 Park Avenue, New York, architects.

Mass., Fall River—The Durfee Mills, Inc., Plymouth Avenue, will build an addition to the steam power house at its textile plant, to cost about $45,000.

Mass., Groton—The Nashoba Fruit Producers' Association has preliminary plans in preparation for the construction of a three-story cold storage plant, 110 x 165 ft., to cost in excess of $100,000, with equipment. E. Sears Read, 177 State Street, Boston, is architect. Stephen W. Sabin is president.

Mass., Springfield—The Boston & Albany Railroad Co., South Station, Boston, will install a power plant at its proposed four-story station and office building on Liberty Street, estimated to cost $4,000,000, for which bids will be received on a general contract until Feb. 12. Fellheimer & Wagner, 7 East Forty-second Street, New York, are architects; Clyde R. Place, 70 East Forty-fifth Street, is engineer.

Mass., Worcester—The Worcester Hahneman Hospital Committee, 281 Lincoln Street, has plans for the construction of a power house at the proposed institution on Lincoln Street, to cost $300,000, for which bids are being asked by Kendall Taylor & Co., 142 Berkeley Street, Boston, architects.

Mich., Detroit—The Board of Works has voted to hold in abeyance the construction of the proposed municipal electric power plant until early in 1927. It is estimated to cost close to $8,000,000.

Mich., Iron Mountain—The City Council plans for the installation of electric-operated pumping machinery at the proposed municipal waterworks, for which bonds in an amount of $390,000, are being sold.

Minn., Breckenridge—The Common Council has tentative plans under consideration for the construction of a municipal electric plant. R. A. Waite is city clerk.

Minn., Detroit—The Common Council is perfecting arrangements for the construction of an addition to the municipal electric plant, to include the installation of new equipment.

Minn., Glencoe—The City Council has preliminary plans under advisement for the erection of a municipal electric plant, to cost in excess of $75,000. J. F. Klobe is city clerk.

Minn., Marietta—The Common Council has plans under consideration for the installation of a municipal waterworks, to include electric-operated pumping plant. J. A. Ellenwood is clerk.

Minn., Pelican Rapids—The Common Council plans for the installation of an electric-operated pumping plant at the proposed municipal waterworks, for which Druar & Milinowski, Globe Building, St. Paul, Minn., engineers, have been selected to prepare plans.

Minn., Tower—The Common Council has tentative plans under consideration for extensions and improvements in the municipal electric plant. J. B. Pearson is city clerk.

Miss., Longview—The Hutchinson & Son Co., R.F.D. No. 1, plans for the rebuilding of its lumber mill and steam power house recently destroyed by fire. Steam boilers, reciprocating engines and auxiliary equipment will be installed.

Mo., Kansas City—The General Petroleum Co., Sixth and Walker Streets, is considering the installation of electric-operated pumping equipment at its proposed local oil storage and distributing works, estimated to cost $70,000. E. W. Goebel is president.

Mo., Springfield—The Springfield Water Co. plans for the installation of electric-operated pumping equipment in connection with proposed extensions and betterments in plant and system.

Mo., Thayer—The Common Council is arranging a bond issue of $75,000, approved at a special election, for the installation of a municipal ice-manufacturing plant, and waterworks.

Neb., Dannebrog—The Common Council, Harold Hald, clerk, will take bids until Feb. 7, for one 15 hp. oil-operated engine; one deep-well pump; motors, and other equipment, including 50,000 gal. capacity tank on 100 ft. steel tower, for a municipal waterworks. The Henningson Engineering Co., National Building, Omaha, is engineer.

Neb., Du Bois—The Common Council plans for the installation of electric-operated pumping machinery in connection with a proposed municipal waterworks, for which plans will be prepared by the Henningson Engineering Co., National Building, Omaha, engineer.

Neb., Fairbury—The Common Council is arranging a bond issue of $150,000, the proceeds to be used for the construction of a municipal power plant and waterworks, for which plans have been prepared by the Hollister Engineering Co., Bankers' Life Building, Lincoln, Neb.

N. J., Edgewater—The Palmolive Co., 360 North Michigan Avenue, Chicago, Ill., plans for the construction of a power house at its proposed local soap manufacturing plant, consisting of a number of units, estimated to cost $1,000,000. Lockwood, Greene & Co., 38 South Dearborn Street, Chicago, are engineers.

N. J., Vineland—The Central Ice & Cold Storage Co., has authorized plans for the construction of a three-story ice-manufacturing and cold storage plant to cost approximately $250,000, with machinery. W. H. Parr is president.

N. Y., Horseheads—The Consolidated Brick Co., plans for the construction of a power house in connection with the rebuilding of its local plant, for which bids will be asked early in Feb. It is estimated to cost $215,000. G. E. Brindible is president.

N. Y., New York—The New York Steam Corporation, 280 Madison Avenue, is planning for the installation of economizers, mechanical fans and other equipment at its power plant at Burling Slip, near Wall Street.

N. Y., New York—The Parlex Holding Co., care of John Sloan, 1 Pershing Square, architect, will install an oil-operated power plant in its proposed thirty-five story office building at Fourth Avenue, Thirty-second to Thirty-third Street, estimated to cost $18,000,000, for which plans are in preparation.

N. Y., Springville—The Common Council has authorized bonds for $42,000, for extensions and improvements in the municipal power plant, with installation of additional equipment.

N. C., Bryson City—The Board of Aldermen is disposing of bonds for $100,000, the proceeds to be used for the installation of a municipal electric plant.

N. C., Charlotte—The Ford Motor Co., Highland Park, Detroit, Mich., is planning for the early construction of a power house at its proposed local assembling plant, estimated to cost approximately $600,000.

N. C., Greensboro—The Southern Milk Products Co., has tentative plans under advisement for the construction of a power house at its proposed local plant, estimated to cost $160,000. E. S. Davies heads the company.

N. C., Rhodhiss—The Southern Power Co., Charlotte, N. C., is perfecting plans for the construction of a hydro-electric power plant on the Catawba River, with capacity of about 40,000 hp. A steam-operated generating station of like capacity is also projected at Duncan, S. C. The plants will cost about $5,000,000.

N. C., Wilson—The Common Council has plans in preparation for extensions and improvements in the municipal electric plant to cost about $175,000, and will soon ask bids. Gladding & Grantham, Wilson, are engineers, in charge.

N. C., Winston-Salem—The Twin City Co., White and Twelfth Streets, plans for the complete electrification of its ice-manufacturing plant, replacing all steam-driven apparatus.

Ohio, Conneaut—The Conneaut Ice & Fuel Co., will soon break ground for the construction of a new ice-manufacturing plant, to cost in excess of $60,000, with equipment.

Ohio, Mineral City—The Hickory Mining Co., Finance Building, Cleveland, Floyd W. Miller, president, plans for the erection of a power house at its proposed local fire brick and refractory plant, estimated to cost $75,000. It is expected to ask bids at an early date.

Okla., Oklahoma City—The City Council will install an electric-operated pumping plant at the proposed sewerage disposal plant and system, for which bids will be received until Feb. 15. It is estimated to cost $1,500,000.

Okla., Picher—The Oklahoma Woodchuck Lead & Zinc Co., plans for the rebuilding of the portion of its mill and power house recently destroyed by fire with loss estimated at $100,000. C. F. Dyke, Baxter Springs, Kan., is superintendent.

Okla., Tulsa—The Producers' Cooperative Association will install a cold storage plant in its new market at Boulder and Archer Streets. D. R. Rees is secretary.

Okla., Tulsa—The Public Service Co. of Oklahoma has plans for the construction of an addition to its ice-manufacturing plant on Eleventh Street, to be one-story 105 x 135 ft., estimated to cost $60,000. The equipment installation is estimated at $150,000, for which a list will soon be prepared. Atkinson & Olston, Mid-Continent Building, are architects.

Ore., Portland—The Hawthorne Ice & Coal Co., has tentative plans for the construction of an addition to its ice-manufacturing plant, 10x8 Hawthorne Avenue.

Pa., Philadelphia—Louis Burk will break ground for the construction of a one-story power house at his meatpacking plant, Third and Thompson Streets, to cost approximately $75,000.

Pa., Saxton—The Penn Central Light & Power Co., Altoona, Pa., is consummating plans for the construction of a new power plant in this section to cost $500,000, and purposes to commence work at an early date.

Pa., Wilkes-Barre—Armour & Co., Union Stock Yards, Chicago, Ill., are reported to be planning for the rebuilding of their local meat-packing and refrigerating plant, recently destroyed by fire with loss of about $125,000.

Pa., Zelinople—The Iron City Sanitary Mfg. Co., 1512-16 Oliver Building, Pittsburgh, is considering the construction of a power house at its proposed local sanitary ware manufacturing plant, estimated to cost about $80,000. C. A. Fagan is president.

S. C., Spartanburg—The Hygeia Ice Co., will remodel and improve its local ice-manufacturing plant, to include the installation of additional equipment. It is planned to double the present output, with estimated cost placed at $100,000. W. R. Willauer is general manager.

S. C., Spartanburg—The Southern Railway Co., Washington, D. C., has tentative plans for the construction of a power house at its proposed local repair shops, estimated to cost $250,000.

Tenn., Gallatin—The City Council will receive bids until Feb. 7, for waterworks equipment, including four motor-driven centrifugal pumps, filter apparatus, etc. B. M. Klyce, Fourth and First National Bank Building, Nashville, Tenn., is engineer.

Tenn., Waverly—The Tennessee Utilities Co., has tentative plans for the construction of an ice-manufacturing plant with initial capacity of about 15 tons daily. A cold storage plant, adjoining, is also considered.

Tex., Houston—The Texas Lighting & Power Co., is arranging an appropriation of close to $3,000,000, for the first unit of its proposed steam-operated power plant, to be constructed during the present year.

Tex., Port Arthur—The Board of Works will install an electric-operated pumping plant in connection with extensions and improvements in the waterworks and sewerage systems, for which bonds in an amount of $1,000,000 recently were voted. Nagle, Witt & Rollins, Port Arthur, are engineers.

Va., Danville—The Department of Public Utilities is considering plans for extensions and betterments in the municipal electric plant, including the installation of additional equipment. Frank Talbot is superintendent.

Va., Staunton—The City Council plans for the installation of an electric-pumping plant in connection with proposed extensions to the municipal waterworks, estimated to cost $700,000, with machinery.

Wash., Longview—The Long-Bell Lumber Co., will soon break ground for the construction of a steam-operated power house at its local mill, estimated to cost $45,000.

Wash., Port Angeles—The Northwestern Power & Mfg. Co., has tentative plans for the construction of a hydro-electric power plant on the Elwha River, with capacity of 20,000 hp., estimated to cost $1,200,000. Application has been made for permission.

Wash., Seattle—The Puget Sound Power & Light Co., is completing plans for the construction of an additional unit at its White River hydro-electric generating plant to increase the capacity 23,000 hp., estimated to cost $1,000,000.

Wis., Hurley—The Common Council plans for the installation of an electric-operated pumping plant at the proposed municipal water purification plant. J. H. A. Grahtz, Metropolitan Opera House, St. Paul, Minn., is engineer.

Wis., Medford—The Medford Canning Co., affiliated with the Oconomowoc Canning Co., Oconomowoc, Wis., is having plans prepared for the construction of a steam power house at its local plant, with installation to comprise two 150 hp. boilers and auxiliary equipment.

Wis., Waupaca—The Almond Electric Lighting Co., is considering plans for the rebuilding of the portion of its power plant recently destroyed by fire.